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ABSTRACT

What data, problems, and concepts are most relevant in determining the role of stimulation in human development? A critical analysis of the relationships between long term stimulation, behavior, and cognitive functioning and development points up biases and gaps in past as well as contemporary approaches. Each of the four sections of this paper focuses upon a central topic and related issues. Theoretical and methodological background and a review of salient features of certain theories of infant and child development are the first topics considered. In the third section, a rough conceptual framework is constructed to aid in interpreting research studies and to furnish guideposts for further empirical exploration. The last section presents selectively reviewed studies on infant learning and cognition by first analyzing research on the early months of infancy and by surveying subsequent development in sensorimotor, perceptual, and symbolic modes. An extensive bibliography is included. (WY)

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Infant Stimulation and the Etiology of Cognitive Processes

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Introduction

It is difficult to imagine from the diffuse and random movement patterns of the new-born child any connection with the complex and orderly movements so characteristic of adults and older children. William James's (1890) "blooming, buzzing, confusion" of the world as perceived by the neonate appears to be an apt description of a state of intellectual affairs which provides little basis for projecting the kind of abstract problem-solving abilities which emerge later in development.

Conceivably, it is just this difficulty in imagining the intervening maze of conceptual linkages and mechanisms of change, which is largely responsible for the long reign in Western culture of the infant mind as a carbon miniature of the adult mind (Thompson, 1952; Aries, 1962). All of the ingredients are seen as present from birth; they are the same aggregate of faculties, simply too tiny to operate efficiently until they grow considerably in size. Medieval painting and drawing furnishes many illustrations of this essentially biological view of infancy in the form of an abundance of "little old men" infant portraits.

As the European world began to tear off the religious cocoon of medieval theology during the Renaissance, the writings and views on infancy and childhood began to be based more on observation than dogma. From the a priori definition of the infant as a child of God, full blown in moral and therefore connative and implied cognitive responsibility, an alternate definition of the newborn as a cipher to which all ingredients must be added began to appear. Perhaps the most influential example of this view was Locke's picture of infancy, as a "tabula rasa," upon which all experience must be inscribed to attain adult complexity.

In many senses this view is surprisingly similar to the former theory. Although it differs fundamentally in that the major source of the infant's growth is to be derived from experience and learning rather than from inherent, biological forces, the types of changes occurring are essentially those of degree. The final adult outcomes are thus a set of faculties realized in both instances by increases in size through the accumulation of building bricks or steps of a uniform type. The child's intellectual functions, in short, differ little in form or quality from those of the adult.

The one-hundred-year era which has been marked by an increasingly formal and careful study of human psychology and development has also seen a proliferation of more sophisticated theories of ontogenesis. Yet, the end of this period, which for painstaking observation of an infant's behavior may be dated especially from Preyer (1888), finds us still with these issues very much alive and unsettled.

Specific Aims

In this chapter we shall organize the presentation of data and the discussion of problems and concepts on early infant cognition and development in the following manner. In the next section, entitled "Theoretical and Methodological Background," we shall review salient features of various theories of infant and child development. We shall not provide a comprehensive comparison but rather attempt to point up major biases and gaps in the theoretical approaches. Such deficiencies have diverted research efforts from important problems and in turn contributed to the present state of limited understanding and information we have of cognitive processes in infancy.

The following section, labeled "Cognitive Definitions and Framework," will probe assumptions and concepts derived from major theoretical orientations as they bear on important issues. We shall also construct a rough conceptual framework as a point of departure for interpreting studies as well as to furnish guideposts for further empirical exploration. Among other sources, our conceptual scheme draws heavily from the theories of Piaget, Werner, and Vygotsky and Luria as well as neo-analytic concepts and an associative learning theory orientation to development.

The final major section of this chapter will review selectively studies on infant learning and cognition, first discussing and analyzing research on the early months of infancy. The survey will next cover subsequent development organized according to the following modes of functioning, namely, sensorimotor cognitive processes, the acquisition of perceptual-cognitive structures, and symbolic mediation and structures (including verbal, mathematical, and musical abilities). We shall then summarize comments on a variety of issues relative to the role of stimulation in infant and human development.

The discussion will be more critical and analytic than exhaustive, partly because the vast bulk of studies have given little attention to relations between longterm stimulation, behavior, and cognitive functioning and development. There will be a central focus upon this problem as well as a consideration of other issues which will be interwoven throughout the discussion. We shall compare descriptive orientations of the past with some suggestions as to the possible cognitive attributes and relationships which may in fact inhere in many experimental tasks.

Theoretical and Methodological Background

The forms and mechanisms of individual development and the nature and complexity of infant "thought" processes remain only dimly understood. The problem of defining these processes appears to rest upon two main obstacles. The absence of language and complex communication processes until later periods of infancy, coupled with the seemingly rudimentary character of infant functioning, has both impeded and probably discouraged the discovery of adequate measurement techniques. Without language, it is not easy to set up tasks which place in relief the full complexity of an infant's ability to comprehend.

The second obstacle has been the delay in appearance of theoretical constructs sufficiently focused to suggest methods of inquiry. Even when promising concepts appear, they do not immediately suggest modes for testing their validity. An interesting illustration of this is provided by the approximately 15 year lag between Hebb's (1949) formulation of early perceptual learning processes and Salapatek and Kessen's (1966) apparent demonstration of the process. Hebb proposed that perceptual organizations become established initially through the pivoting of infant eye movements around salient figure-ground characteristics of objects, such as the apexes of triangles. Through use of a "motion analyzer," Salapatek and Kessen have devised a technique for charting accurately the paths and shifts in the neonate's eye movements in his perception of projected images of triangles, lines and other configurations. In this manner, Kessen has apparently been able to show that the infant's initial patterns of viewing the points and lines of triangles tend to approximate closely Hebb's original formulation.

Few of the several main orientations to or theories of infant functioning and development have proved useful with respect to an exploration of the infant's cognitive potentials. In recent history we have been presented with four major classes of theories, principally, developmental, psychodynamic, stimulus-response learning theories and cognitive structural theories. Under each of these categories may be grouped many varieties, and there is often a commonality of constructs which vary mainly in language form and the conceptual apparatus within which they feature. This is particularly true of the contemporary scene as illustrated by the emergence of mediation theory, which seems to be leading to some degree of convergence between stimulus-response, behavioristic and cognitive theories.

Orthogonal to these sets of theories, there are additionally a number of issues which appear to divide the adherents within schools as much as the memberships differ among the several theoretical persuasions. Among these transcending cross currents are the relative weights accorded to genetic versus experiential sources and mechanisms of development, the size of the space-time units of analysis, the role of emotional and motivational factors, the importance of reinforcement or feedback and the active versus passive stance of the child with respect to developmental-learning processes. For example, both the earlier forms of developmental theory espoused by Gesell (1954) and the main thrust of cognitive structural developmental theory following Piaget (1952), embrace molar units and long time arcs of development. These orientations are similarly vague with respect to precisely how the developing infant and child moves from one phase and form of functioning to the next. In contrast, there are marked differences between the two outlooks with respect to the complexities of their explanations and the roles accorded to cognition and other processes.

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Although it is not the place here to present a comparative analysis of theories of infant and child development, it may be of value to point up certain major features of theories which have in different ways served to retard research on problem-solving at the infant level. Psychodynamically oriented theories have defined the organism in general as a fragile creature beset by emotional conflicts, varying in the balance of satisfactions and dissatisfactions realized. The infant is almost entirely a vehicle of impulse, seeking pleasure, while reality dimensions are principally obstacles to be accepted painfully and reluctantly in the formation of a more cognitive type of agent, the "ego." It is true that there are cognitive-structural features (Wolff, 1960) and analyses of thought processes have been made (Rappaport, 1951) within the framework of psychoanalytic theory, particularly in its later ego psychological or neo-analytic forms(Horney, 1939; Thompson, 1950; Hartman, 1958; Sullivan, 1953; Green, 1964). Yet the general framework remains largely oriented toward socio-emotional processes and psychopathology.

But an over-focus upon motivational processes and drive functions as the basis of infant behavior and development are only one of the major limitations. Another is the origin historically of psychodynamic theories in a framework of adult psychopathology. Many of the concepts are thus retrospective reconstructions derived from a context of uncontroled clinical observation on adult problems of emotional maladjustment. However suggestive ideationally, few of these observations have been subjected to careful scrutiny or empirical tests on infants and children in normal settings (cf. Orlansky, 1949). Perhaps the central weakness in psychoanalytic drive theory is its concentration upon a single mechanism of explanation, interweaving a central motive throughout all conditions of functioning. There is always a single, underlying drive mechanism postulated in the form of "libidinal" or psychosexual energy, however expressed through developmental stages of zonal modes of functioning (Erikson, 1950), in particular, oral, anal, and phallic zones. In this manner all complex behavior is reduced to a one cause behind the scenes. In its later neo-analytic versions, the pervasive force becomes anxiety, which becomes the underlying agent determining the course of development and steering the individual from situation to situation.

In contrast, it is perhaps misleading to place developmental descriptions in the realm of theory at all. They are more conveniently described as collections of observations of infant and child development. These observations range across a variety of different behaviors, principally those of motor, social and verbal behavior, of which the latter two tend to be superficial and over-simplified. Cause-and-effect sequences are poorly considered. Here again there is assumed to be a single, dominating principal governing behavior, namely, the unfolding of biological forces developmentally, operationally defined mainly in terms of linkages to age levels. The bases for age linkages are quite loose, however, since there is little attempt to coordinate and integrate the various processes in terms of a coherent conceptual explanation despite the underlying biological assumption. Internal mediational processes, cognitive, emotional or otherwise are generally very sparsely handled.

Methodologically, this outlook has led to a preoccupation with gathering age norms which have been generally assumed to represent maturational universals for the course of development (Fowler, 1962). Few research studies have tried to relate the tremendous range of inter- and intra-individual differences which appear in rates, levels, types and styles of development to the widely different histories children encounter. What, in fact, may be developmental, cultural-subcultural trends are labeled biologically determined, developmental age universals. Gesell's (1954) global concepts of development are the nearest to anything in the nature of theory. His notions of "developmental direction" (i.e., cephalo-candal and promimo-distal) and "reciprocal interweaving" (fluctuating alternation between predominance of a newly acquired trait and its gradual integration into smoothly coordinated action systems) are more in the nature of architectural frameworks within which one can observe the long-range processes of development. Such broad concepts furnish little in the way of satisfactory explanation for how the infant and child develops from one step to the next in a given process.

Like the earlier developmental descriptive orientations of Gesell and his followers, cognitive structuralists have dealt in wide ranging arcs in theorizing about development. Piaget's (1952) theory of the continuing shift between forces of accommodation (adjusting to external stimuli) and assimilation (incorporating the new adjustments to previously acquired cognitive action patterns (schemata)) in a process of constant balancing or equilibration actually bears some resemblance to Gesell's earlier concept of reciprocal interweaving. The level of abstraction is such as to provide inadequate information on how specific traits and understandings emerge developmentally. Notwithstanding this limitation, the theories of Werner (1957) and Piaget (1952) and Vygotsky (1962) and Luria (1961) must at least be recognized as cognitive theories, theories which do tend to take account of internal mediational processes and structures emerging in the course of development. While still restricted to defining the characteristics and sequences of infant and child development, as opposed to searching for mechanisms and causes, these orientations are much more elaborated, complex and internally organized conceptually. Moreover, all of them, particularly those of Vygotsky and Luria, provide for, or at least do not rule out, the possibility that mental structures emerge out of cumulative interaction with environmental circumstances. Unlike the microfocus on single, stimulus-response relationships, which have dominated learning theories historically, the conception is one of an active, planful organism, moving in an environmental medium in complex patterns of functioning.

The levels of generality at which the theories of Piaget, Vygotsky and Luria tend to conceptualize, however, lead to an emphasis upon general characteristics of sequences of development, following along a single course of degrees and levels of abstraction and complexity. The ideas of Vygotsky and Luria, on the other hand, (partly in contrast to Piaget and Werner) are linked to systems of explanation derived from analyses of specific conditions and processes of learning and development. Although there is some correspondence between these cognitive developmental theories and age, they are rather thin bonds. The central organizing concept is rather one of internal structures evolving sequentially through levels of complexity and abstraction in task performances and logical operations.

One of the principal deficiencies of cognitive conceptual orientations is the general lack of stress on affective or motivational processes, although these have been alluded to in general statements of the theories, such as those of Piaget (Flavell, 1963; Piaget, 1952). The discussions, elaborations and the empirical reports of observations, as well as latter day research have in general included little in the way of definition of motivational conditions.

Stimulus-response, learning theories, both classical and current, have made a more thorough analysis of conditions of learning. At the same time they have generally adopted so microscopic a focus and engaged in such task minutae that few experiments conceived under the aegis of learning theory have grappled with complex forms of behaviors or of internal mediating processes and sequences of infant (and child) development. The high empirical and methodological concerns within which learning theory has been immersed, nevertheless, have been at once both their strength and a weakness. Although narrowing down the type of problem on which work has been focused and thereby limiting the information developed, there has been tremendous work on experimentation and research. The result has been a continuing, accumulating body of information on infant functioning, particularly with the expansion of techniques for infant study (Kessen, 1963; Lipsitt, 1963).

The recent growth and prominence of cognitive theories, moreover, has tended to expand the thinking and type of problem upon which experimental infant and child psychology has worked. This has taken the form of development of mediation theory, in which there has been more attempts to encompass symbolic processes and to account for internal associative processes.

Among other strengths of SR learning orientations has been the attention to motivational conditions and processes, largely in the framework of primary and secondary reinforcement theories and conditions. On the other hand, learning theories generally, both classical and instrumental, operant conditioning theories, have in general dealt with very short time spans. Little effort has been made to trace the development of an infant and child through time as a function of variation in types and intensity of environmental-organism interaction cumulatively. The description of stimulus and motivational circumstances has, accordingly, been grossly over-simplified and limited in purpose and meaning.

Cognitive Definitions and Framework

What are cognitive processes and abilities and to what extent are they present or do they develop during the first year or two of human life? Most generally, cognitive processes may be defined as internal, mental processes. They take the form of action structures which mediate between environmental conditions, from which stimulation emanates, and the visible responses and actions of the organism.

For many years the main thrust of general and experimental psychology has preferred to explain functioning of the organism solely in terms of observed behavior, the perceivable relations between the environment and the actions of the organism. Developmental psychology in its earlier form emerged under the leadership of Gesell and his followers in the twenties' and thirties' during the ascendency of the reign of behaviorism. It is, therefore, not surprising to find early developmental orientations largely descriptive of the external forms of behavior, postulating little in the way of internal, mediating mechanisms. The reasons for the extremeness of this position are, of course, partly historical, but they also lie in the evident fact that there is no way of directly apprehending internal, psychological processes. This forces us to construct a scientific psychology of human functioning entirely on the basis of inferences. Probing for cortical, neurophysiological phenomena fares no better since the best we can do is to study/~~the functioning of brain damage~~ brain anatomy or the effects of brain damage upon behavior, brain damaged from either accident or necessary

surgical intervention.
~~either from accident or surgical intervention.~~ Or, again, to make inferences from such physiological by-products as electroencephalographic (brain) waves (EEG), correlating them with behavior.

But to deny or ignore the existence of internal mediating processes is in many ways similar to attempting to study the complex functioning of an intricate piece of machinery and define its mechanisms simply through external observation of its interactions with the environment. There is little prospect, given our present understanding and level of techniques, of directly grasping the nature of internal mechanisms. Yet, to avoid postulating and discussing the kinds of operations that the internal "semiautonomous" central processes (Hebb, 1963) actually perform is to overlook the key role some system of internal mechanisms plays in the time-space, causal chain of behavior. It is, essentially, to write off the fact that these internal "agents" can, by means of symbolic representations and manipulation, plan a series of distal confrontations and constructions in the environment with considerable independence of any direct and immediate form of environmental stimulation.

It seems far more reasonable to observe the obvious fact that human organisms live and operate in an environmental medium yet, as a result of development, are not formed as mechanical systems univocally tied to the medium. Mental processes, in proportion as they develop in complexity, permit the child to increase the efficiency of his functioning in planning and controling his relations in and with the materials of the medium. Mental structures may be defined as systems of information processing and action, evolving from interaction with and symbolizing (in varying combinations) the actual organization of the external, physical and social world. Mental structures and processes are problem-solving systems which enable effective mastery of the world.

There are, of course, many limitations upon even man's ultimate capacity to apprehend dimensions of reality. Yet it may be assumed that the levels of cognitive complexity attained by most people are much below their biological potential. Much of the functional variability in intellegence among individuals is due to variations in the kinds and amount of stimulation experienced over the life span, as we shall attempt to document in this chapter.

In much contemporary thinking, especially represented in the concepts of Vygotsky (1962) and Luria (1961), language is the primary vehicle enabling man to multiply the complexity of his intellectual functioning many times. While language may not be co-extensive with thought processes, nor even the sole agency through which cognitive operations are expressed, it would appear to be the main form in which cognitive functioning is organized. According to Vygotsky, Luria and others, language serves as the chief means of organizing thought processes, furnishing a basis for extending the generalization of cognitive processes, the level of abstraction, and the degree of objectification of reality. It is a shorthand system which makes it possible for us to discriminate, sort and regroup large masses of information in a highly selective manner. By developing a complex network and hierarchical system of symbols, language enables us to code and represent seemingly endless data on reality structures and processes. Through the acquisition of symbol systems, we become able to regulate, control and steer a course of action planfully and productively to create and build ever more complex structures in the world for whatever purposes we choose. The power to symbolize is the power to construct in our minds new conceptions of environmental arrangements *prior* to testing them in reality.

If the foregoing sketches man's potential for complex problem-solving at later stages of development, given sufficient education, there is still the task of establishing the extent of cognitive involvement in the infant's mental processes. There is probably widespread agreement on the basic simplicity of infant reflexes and responses during the earliest days and weeks following birth. During this first phase, the complexity of action systems is indeed minimal, consisting of the immediate potential for engaging in crying and sucking behavior (yet even here some minimal degree of learning appears involved (Kessen, 1963; Razran, 1961)), sleeping and a variety of other more or less specific reflexes. These include the plantar and tonic neck reflex, and the ability to execute diffuse movements of the trunk and appendages as well as the effective operation of the viscerotonic functions (swallowing, digestion, elimination, and so on).

While this is the range of normal functions available to the neonate, it is not surprising that we might expect little more at the point of birth. A more important question is where does the child go from here in his development? At what rate does and what are the variety of areas, modes and directions toward which the child can evolve, to the extent there can be variation during the first 18 months of life? There is actually much observational and some experimental evidence that cognitive processes appear to take root quite early in development (Fowler, 1962a, 1966). Moreover, mental processes not only take different forms and different paths, but also evolve at different rates in different individuals, as a product of (among other things) cumulative differences in their experience, even in infancy, as we shall try to show. Ordinary observation tells us, for example, that, normatively, a child at 18 months has attained some mastery of language processes. According to a compilation of McCarthy (1954), studies of language development typically report a vocabulary of some two-to five words by the age of 18 months. Joining two words in speech or the use of first phrase or sentence appears shortly thereafter between 20- and 24 months.

There is, nevertheless, some question as to how we should interpret these early forms of language and other infant behaviors we shall report on below. Are they to be classed as simple forms of associative learning, differing in kind from more complex, cognitive learning? Or, do they involve problem-solving operations which, while still to evolve to increasingly complex forms of cognitive functioning, nevertheless, even in their early form partake of many of the same dimensions which permit classification as cognitive process learning?

There is a considerable amount of evidence accruing, recently summarized by S. White (1965) which discloses the operation of a basic transformation in the kind of intellectual functioning of which the organism is capable at about the age of four-to seven years of age. The Kendlars (1962, 1963), for example, have observed sharp trend differences in the child's approach to discrimination learning as a function of age. On a discrimination task requiring discrimination between two stimuli differing on two dimensions (e.g., size and brightness), younger children generally adopted stimulus-response, single dimensional learning, that is, they shifted to a different dimension (e.g., from size to brightness) as a basis for discriminating between stimuli. This is known as a non-reversal shift. Older subjects tended to utilize mediational processes apparently; that is, when faced with a similar situation, they tended to discriminate between the two stimuli on the basis of the same dimension (e.g., size), but reversed their choice to the opposite direction or value of the dimension (e.g., large to small). According to the Kendlars' interpretation, non-reversal shift-type learning assumes a direct association between the stimuli and the motor responses of the child. Reversal of direction on the same dimension, however, requires some kind of internal mediational process.

Luria and his associates (1961) have described what they believe to be a fundamental shift in the generality of language mediation of intellectual processes from younger to older children occurring around the age of five to seven. Their experimental findings report other kinds of shifts, one of these appearing about the age of 16 months, the earliest age he found children able to inhibit an ongoing, sensori-motor action through verbal instruction as compared to single unit, conditioned stimulus signals. According to their thinking, ~~the chief point upon which~~ these differences rest on the pivotal role which language mediation comes to assume in intellectual functioning. The acquisition of language enables the older child to inhibit direct associative responses through the mediational or bridging mental operations which language processes come to serve.

Much of the evidence on these "shifts," unfortunately, is drawn from short-term learning experiments, comparing different subjects at different points in their life histories. This framework fails to control for differences in the children's experience, which are actually reflected in large standard deviations at the same age. That we ignore the consequences of prior history at some peril is nicely illustrated by Ling's (1941) classic experiment on form concept learning in six- to 13-month-old infants. Her study is also valuable for demonstrating the comparative value of longitudinal as opposed to short-term learning experimental paradigms. In contrast to the Kendlars, she found that through pursuing a longitudinal stimulation program with each infant for several hundred trials over a period of months, infants were able to acquire certain concepts of abstract form. By the age of 13 months, all infants were reliably able to discriminate between three-dimensional forms (circles, crosses, squares, triangels and ovals), despite perceptual shifts in relative size and position, spatial orientation, number and even of reversal shifts along the same stimulus dimensions.

With the limited amount of evidence available-- particularly in the sphere of longitudinal-developmental studies (Fowler, 1966)-- we cannot rule out the existence or importance of such qualitative shifts in levels of cognitive functioning with development. But the existence of such shifts and their timing is far from well established. Moreover, the existence of shifts at any developmental period does not preclude the possibility that infant learning may involve cognitive operations. That is, pattern and mediational functioning and symbolic representation, as opposed to simple unit, associative control processes may be inducible as early as the firt year, as Ling's (1941) study tends to show. In short, while there may be a number of transformations in the forms of organization of cognitive processes over the span of development, there also may be many basic characteristics of infant intellectual functioning which can be effectively described as cognitive during the early periods.

In this survey we shall sample selected studies of infant behavior in order to analyze and redefine the experimental variables and task dimensions in terms of cognitive functioning. We shall explore the roots, characteristics and a few maximal attainments of cognitive processes (where investigated) during the beginning periods of development. It will be our aim to sharpen awareness of the incipient, cognitive nature of infant functioning which empirical-normative descriptions of behavior have long obscured.

The attempt to re-define functioning in cognitive dimensional terms entails more than the simple selection of a preferred theoretical framework. The past emphasis upon reducing analysis to superficial behavioral descriptions and/or short-term "objective," stimulus-response relations has contributed toward dwarfing the development of our methodology and technique, as well as blighted our imagination to the cognitive potentials in infancy. Only by the systematic analysis of infant behavior within a more complex and molar cognitive framework, using concepts such as those of Piaget (1952), can we hope to discover these infant potentials. We are equally in need of a vastly improved longitudinal methodology, which systematically establishes the relations between environmental stimulation and cognitive processes on a cumulative, developmental basis.

We turn first to miscellaneous short-term studies from different experimental and conceptual settings--especially studies of infant conditioning, perception and problem-solving to extrapolate what appear to be salient cognitive structural features and relationships inherent in the tasks and stimulus situations.

Among criteria useful for evaluating the cognitive complexity of task functioning are the following: In general, we can assess the complexity of the stimulus pattern and the response pattern or task performance required, according to the number of discrete elements and relationships involved in each.

At the simplest level, there may be, for example, a single unit stimulus[1] (e.g., a point of continuous light or sound) to which the organism comes (learns) to respond with some brief and relatively simple and innate reflex (e.g., crying, sucking). Complexity enters at the stimulus end through gradually increasing the intricacy of an external pattern or structure[1]. This means multiplying the number of components in a stimulus pattern and the organization of their relations in a horizontal network and/or superordinate system.

While the complexity of cognitive structures is seen (and functions) through the response processes, these can be evaluated through the complexity of the means-end action systems the organism must carry out in a given task situation. Cognitive complexity is demonstrated, in short, in proportion to the complexity of operations which an infant must perform with stimulus systems of increasing complexity. Perceptual discrimination between two complex structures on a simple pointing basis (e.g., car versus dog) may involve less mental complexity than using the objects for some purpose (e.g., pushing a toy car and petting a toy dog). Complexity is further shown according to the number of interrelations of part features, functions and mechanisms utilized in a coordinated fashion in handling and problem-solving with sets of objects, e.g., employing the steering wheel, ladders and hose on a toy fire truck correctly in function and sequence.

It is through perceptual-motor manipulation of objects, together with

[1] Stimulus complexity is defined here in terms of the complexity with which the human sensory apparatus is capable of processing stimulation under ordinary molar conditions without the aid of special instrumentation, e.g., magnifying glass, microscope, audiometer, etc.

the use of symbolization, that the child becomes able to create new syntheses at increasing levels of abstraction, in both space and time. In this way the developing child moves from sensori-motor and infralogical to logical forms of conceptualizing. He comes to learn, not only about the constancy of objects but, slowly, through experience, acquires an increasingly stable, conceptual picture of the conditions under which permanency, reversibility, transitivity, and conservation of matter are maintained. He has the potential, ultimately--not only to acquire logical structures and styles for conceptualizing and solving complicated problems in the external world--but to learn to construct, intricate logical systems of his own to extend his mastery of the world.

Neonatal Period and Early Months

Research on the first few days and weeks of postnatal life has been of two main types, learning experiments and the study of sensory-perceptual capabilities, As a result of limitations in experimental design, the role of stimulation in developing these capabilities is not always placed in relief. It has now been rather well established that neonates as early as a day or two old are capable of discriminating perceptual patterns visually. In a series of experiments, Fantz (1958, 1961, 1962) has demonstrated the ability of neonates within the first week of life to discriminate reliably between two dimensional patterns. Infants less than 24 hours old were able to perceive the difference between one-eighth inch, striped, black and white patterns from uniform gray stimuli at a visual distance of nine inches. Over the first few weeks, infants were able to discriminate between squares and checkerboards, two face patterns (including scrambled faces), vertical stripes and circles and other two-dimensional objects. Fantz (1961) and Venger (Zaporozhets, 1965) have both shown that infants can also reliably discriminate between three-dimensional objects at two to four months of age.

These investigators along with Thomas (1965), have also found that infants during the first six months of life consistently prefer pattern over color and more complex over less complex patterns, such as checkerboards against simple squares and more novel against more familiar stimuli. Moreover, Thomas' infant studies indicate that infants respond preferentially to sets of designs according to the order of their complexity. This follows the work of Dember (1965) and Earl (1961) which suggests that organisms tend to choose objects of optimal complexity value. Complexity value is defined as a level of complexity just above the comfortable level at which the structures of the mind have reached at any period in an individual's development.

Several principles of stimulus presentation are derivable from this collection of studies. Attention and curiosity and therefore learning may be mostly easily facilitated in infants by rating all stimuli on a scale of complexity values for each infant, presenting only stimuli within the assigned value range, according to the infant's cognitive level. This line of experimentation also suggests the value of sequencing operations. Stimulus programs should be designed in terms of gradients of complexity. The order of presentation would then follow a sequence of increasing complexity, each stimulus pattern presented falling at the proper complexity value, which would gradually increase as the child learned.

In the realm of color, infants a few weeks old can apparently reliably discriminate between color combinations of red and green, red and yellow-green, red and blue-green, yellow-green and blue-green, green and blue-green, virtually 100 per cent of the time (Chase, 1937). The latter set of operations, however, may be described as single unit, stimulus discriminations, whereas perception of pattern involves variation in number, arrangements and configurations of stimulus units within organized patterns. In form perception, the figure-ground discrimination which Kessen's infants were able to make at the corners and edges of triangles may be considered the equivalent of stimulus units, compared with the complex pattern perception reported by Fantz and others. Single, stimulus unit perceptual discrimination has been demonstrated during the first two weeks of life across a range of sound frequencies and light intensities (Bronshtein et al, 1958), as well as in movement of objects (horizontal, vertical and circular) (Beaseley, 1933), odors (Engen et al, 1963) and possibly differences in pitch (Leventhal and Lipsitt, 1964).

From the foregoing it is clear that the human infant at the time of birth or within the immediately ensuing weeks typically develops a fairly complex sensori-perceptual apparatus in several modalities for exploring and acquiring information with respect to the nature of the physical structures of the external world. But this class of experiments on human infants has built in almost no control of the type, volume and deviation of external perceptual stimulation to reveal its impact upon perceptual cognitive development. Some of the most illuminating findings on the function of stimulation have emerged from studies on sensory deprivation, of which most formal experimentation centers on the development of infrahuman animal species. Because of their dominant longitudinal framework, these will be summarized in a later section.

We shall turn now to questions on the form, direction and extent of emergence of cognitive motor action systems during the initial months of infancy.

The principle form which the study of infant motor learning processes has taken, have been studies of infant conditioning. Studies of conditioning focus on the response or motor action aspects of human learning and activity processes. A number of experimenters have successfully conditioned infants to a variety of auditory (e.g., buzzer) and visual (e.g., light) stimuli as early as the second week of life, although efforts have not been uniformly successful until some weeks later in life, when more stable response patterns are typically established (Dashkovskaya, 1953; Marquis, 1931). The model of the classical conditioning process in these experiments entails the formation of a single connection between a simple unit stimulus and an innate reflex.

Observation of newborns discloses a certain amount of learning involved in the sucking reflex; the initial response is sometimes either virtually absent or crude and the infant often benefits from a certain amount of starting and guiding before he develops effective control of the sucking activity to obtain milk through a nipple, from either breast or bottle (Kessen, 1963). Many infants make adjustive movements indicative of a self-teaching process (autogenesis, Dennis and Dennis, 1941). According to Peiper (1956) there are three main forms of sucking, a lapping technique (little used in humans), a pressure discrepancy methods (most frequent) and a biting style (confined to bottle babies), which infants come to choose between very early in the development of the feeding process. But whether guided or self-taught and regardless of method, the fact of change and improvement in sucking technique suggests the importance of some beginning mediational process in the regulation of behavior through adaptive interaction with the environment.

Piaget (1952) defines the development of such regulatory control as a process of acquiring sensori-motor schema. In the early stages, these systems are closely tied in space and time to the specific environmental conditions in which the shaping of the response system through learning originally occurred. But however limited, do we not have the form of a means-end action system which is the basic form of all subsequent problem-solving activity, however complex? To the extent that variability and change can be shown to take place, even in simple reflexes and from birth, there appears to be some mental control and steering of behavior, however rudimentary.

Certain types of reflexes in the neonate, such as the Moro and plantar reflexes, appear to undergo relatively little of this form of alteration and development in response to stimulation (McGraw, 1935). Apparently as a result of a comparatively low position of complexity in the central nervous system hierarchy and because of their early phylogenetic origins in human adaptation, they are altered and feature little in subsequent developments of the child. It is rather with those reflex systems which do show modification with experience and increasing purposive control that we are concerned in demonstrating the roots of cognitive processes in infancy.

Assuming then the early acquisition of this primitive means-end action system, self-guided sucking to obtain nourishment (or sensory gratification with thumbs and pacifiers), in what manner do the classical conditioning processes alter this simple system? It would seem that the simplest level of functioning is based not on the conditioned response but on the direct relation between the elaborated (sucking) reflex system and the satisfying goal being worked for (e.g., milk or sensory gratification), what has been termed the "unconditioned stimulus." If this is so, then the acquisition of conditioned responses introduces a third dimension in the structure of infant-environmental interactions, the association of the emerging sucking reflex system with a second environmental element or condition, for example, a simple sound or flash of light. This new element may best be defined as a *signal*, presenting problems to the infant of attending and orienting to the new dimension in both space and time.

The new stimulus (conditioned stimulus) is presented to the infant beginning immediately *prior* to the presentation of the goal stimulus (unconditioned stimulus). Changes in behavior which are observed, therefore, following several days or more of training to the new stimulus, which could not be elicited prior to the training (i.e., in the absence of association with the goal stimuli), suggest the formation of a mediating connection in the infant's mind. The new or conditioned stimulus must come to have some *meaning* as well, that is, some *function* for him in relation to the original goal stimulus. The characteristic changes observable upon the occurrence of this new stimulus, namely, the advent of or increases in sucking, mouth-opening and related movements, together with cessation or decreases in crying and general bodily movements, resemble preparatory actions. These indicate the presence of internal *expectations* that food (the goal stimulus) is imminent (Marquis, 1931). There appears to be established accordingly, some kind of three-way set of interconnections, between the infant and each of the stimuli and between the two stimuli themselves; that is, *relations between* the stimuli (as well as *to* the different stimuli) are established in the infant's mind in the form of stable, functional expectations. The stable form, timing and patterning of his movements would seem to reflect the presence of some internalized structure, similar to Piaget's schemata.

Historically, much emphasis has been placed on the seemingly automatic, character of conditioned response learning, reducing behaviors acquired in this framework to the realm of more or less "mindless," mechanistic operations and functions of the autonomic nervous system. Yet there may be cognitive mediational aspects involved which are difficult to overlook. These are additionally verifiable if one encompasses for consideration not only the smooth end-product conditioned response, means-end action systems but the orienting responses which appear during the course of the conditioning-learning curve periods (Razran, 1961).

During the early emergence of conditioning experiments and behavioristic theories, interest centered on the stable relationships which developed between stimulus conditions and response patterns. Yet even Pavlov noted the orienting activities typical of the early stages of conditioning, which can be described as more flexibly adjustive to the salient stimulus dimensions of the environment (Razran, 1961). Tolman (1932), in fact, defined cognition as a process of "object adjustment." As conditioning develops and stabilizes, the more conscious or cognitive operations gradually drop out to become automatic or regularized in the form of "habits."

The process can be illustrated through the experimental techniques developed by Bronshtein and his associates (1958) in the Soviet Union and adapted by Lipsitt and his colleagues (Leventhal and Lipsitt, 1964; Engen et al, 1963). In these studies two stimuli in a given stimulus dimension (e.g., light, intensity, pitch, sound localization, odors) of varying frequency, intensity or position are presented to an infant (as young as one day old) who is in the process of sucking (Bronshtein) or in a neutral or baseline state (Lipsitt). The initial response involves cessation of sucking or increased body and leg movements and respiration, followed by adaptation over a series of four or more trials The adaptation consists of resumption of sucking or simplification of movements and breathing toward baseline conditions. In an experiment of Engen, Lipsitt and Kaye (1963) the adaptation of the 32- to 68-hour-old infants is described as a gradual response evolution. The response over the trial series changes from diffuse and disorganized body movements to a smooth and efficient turning or retracting of the head to escape a strong olfactory stimulus.

From this technique it is thus also possible to establish that the limits of sensory differentiation in the infant are much greater in a wide variety of sensory modalities and stimulus dimensions than had been previously demonstrated. Each time the stimulus differences along a dimension shift and the infant orients (as measured by changes in behavior), we have an index of sensory discrimination.

But equally important, these experiments disclose the "object adjustive" features of infant behavior, even at the neonatal level, the orienting toward the salient features of the stimulus situation, followed by gradual accommodation. The latter takes the form of the elaboration and coordination of innate reflex systems or the acquisition and development of new and efficient means-end (action) systems. One of the significant aspects is suggested by the ability of the neonate to inhibit an ongoing response activity (sucking) to stimuli as well as increase it. As we shall observe from the studies of Luria (1961), however, the kind of inhibition possible in the early months is quite limited, in comparison with the more regulative type of control emerging at later periods. It appears, therefore, that cognitive mediation may be acquired by infants shortly after birth, although restricted in form and complexity. There is little more than some initial flexibility in ability to shift in attending or orienting toward stimulus goal objects. The neonate can, at best, learn to smooth out, elaborate and associate simple, innate reflex systems to a two (simple unit) stimulus chain sequence, stimuli which are separated by no more than a few seconds in time and proximal in space.

The limited levels to which infant learning can propel infant development during the immediate postnatal period should not, on the other hand, blind us to its function. Despite the tenuousness with which conditioned responses are often established during the first weeks of life (Kessen, 1963), the conditions for learning available make a difference. Kasatkin (1960) found that infants can form conditioned responses during the second month of life, regardless of the degree of prematurity of birth. In the words of El'konin (1957) (who cites Kasatkin)

> "...the functional maturity of the cerebral cortex depends upon its actual functioning; this alone can explain its earlier maturity in premature infants."

The contrasting volume of stimulation available for development between conditions outside (postnatal) and inside (prenatal) the womb appears to make the major difference. The influence of more refined differences in beginning life experiences, which probably affect ease and rate of conditionability and a variety of developmental functions, becomes more manifest within the framework of longitudinal-developmental studies like those of B. White (1964, 1966) as we shall now describe.

Stimulation in Subsequent Development

If we can find roots or primitive features of cognitive functioning in earliest infancy, the scope and complexity of cognitive functioning appears in bolder form in later studies of infant learning and development. Because few of the learning studies to be reported attempt to engage the infant in learning a series of tasks of increasing levels of difficulty on a longitudinal basis, we really have very little evidence as to the reaches of cognitive potential in infancy as we have earlier reported (Fowler, 1962a, 1966). The classes or aspects of functioning into which we have divided the studies include (1) sensori-motor cognitive operations, (2) the acquisition of perceptuo-cognitive structures, (3) symbolic mediation and structures, and (4) discussion of related issues and concepts. These divisions are to some extent necessarily arbitrary; for example, some of the studies attempt to relate motor processes to verbal functions or again, sensori-motor problem-solving is likely to involve the acquisition of cognitive structures.

Sensori-motor Cognitive Operations

In a series of studies on conditioning infants from birth to six months of age, Papoušek (1965) has attempted to demonstrate the emergence of purposeful activity in the infant's functioning. Using as a response what he terms the food seeking reflex of head turning, the infant is conditioned either to a bell or a buzzer in association with milk (the unconditioned stimulus) placed to the left or right side of his head. Stable but weak conditioned responses of long latency appear during the second week of life. Lateral differentiation between left and right turns was completed by six weeks. During the four- to six months' age period, the infant finally becomes able to make voluntary left or right turns, that is, to make purposeful response shifts, according to which side the sweetened milk as against the unsweetened milk appears. This gradual voluntary shifting of the infant's head from left to right as the sweetened milk is shifted from side to side follows the conditioning of both sweet and unsweetened milk to the same stimulus. It appears, in other words, that the infant learns to search from one side to the other, over a period of trials when he doesn't find the milk on the expected side.

There are several studies focused on grasping or manual prehension, all of which involve visually directed reaching. In one study a single infant was trained to grasp and coordinate the holding of the bottle of milk in order to carry out self-feeding (Fowler, unpublished study). Self-bottle-feeding of this kind appears to involve the coordination and sequencing of a fairly complex set of manual, oral and visual operations, which, particularly in the learning phases, may be assumed to involve considerable cognitive mediation in building up the necessary sensori-motor action schemata, following the thinking of Piaget (1952). Forerunners of this type of complex coordination of grasping and other motor actions involved in self-feeding are evident in an earlier study. Curti (1930) trained an infant of approximately four-and-a-half months to grasp a rattle in a series of 14 trials spaced over a period of one week. As we have observed earlier, the "smoothing" operations which occur as the infant comes to master the skills involved are apparent in the shifting from a diffused, random-type of grasping response to a well-coordinated simple grasp. There is a gradual elimination of most of the gross body and other dysfunctional movements.

More recently, B. White and his associates (1964, 1966) have been studying through experimentally controled observations the etiology of these kinds of visually directed movements. They have traced and classified a normative sequence of development over the first six months of life in terms of eight stages of development culminating in visuallly directed reaching just prior to the age of five months.

Of significance in the present context is the success of the investigators in manipulating environmental crib conditions of institutionalized children in a way that experimental groups achieve top level reaching in approximately 60 per cent of the time required by control groups, or at less than age three months. The various combinations of experimental stimulation include enhanced opportunities for self-initiated movement, exposure to a great variety of color, form stabiles in the crib,and extra handling by adults.

There was evidence in these studies that certain focused forms of stimulation, particularly the use of specially decorated pacifiers place at the point of normal infant visual accommodation (eight to ten inches), accelerated further the development of visually directed reaching. On the other hand, there was a tendency of specially stimulated infants to be slightly delayed in hand regard and swiping responses. This unevenness of development might be avoidable if all aspects of a series of learning tasks are subjected to careful analysis to insure the coordination of sequencing operations. In this manner components of each sensori-motor cognitive structure can get integrated into effective schema.

Investigations of Dennis and his associates (1957, 1960, 1965) in the Middle East point toward adequate environmental stimulation in the early years as essential for cognitive skill development in the gross-motor sphere. Gross-motor development has long been considered to be particularly tightly governed by biological maturation, as even Dennis himself had emphasized in an earlier study (Dennis and Dennis, 1941). Dennis has been able to demonstrate that infants in institutions under conditions of insufficient stimulation tend to be extremely retarded in such gross-motor developmental activities as sitting, creeping, crawling, walking and standing. Moreover, Dennis and Sayegh (1965), working with a group of five understimulated institutionalized infants, were able over a period of one month to produce significant improvement in infants' sitting performance and generally in developmental age scores on the Catell scale, compared to eight controls who gained only slightly. Stimulation consisted of 15 days of one-hour-per-day opportunities to sit and manipulate a series of small objects.

The role that particular forms of stimulation may have in development is illustrated by a study of the influence of a flexible, child rearing methodology (generally known as a permissive orientation) upon the test scores of 316 infants followed in a Yale University rooming-in project (Klatskin, 1952). By the ages of approximately 12 and 13 months the children were found to be generally advanced beyond developmental age norms in gross-motor functioning but not in verbal and fine, visual-manual coordination. Evidently, the enhanced opportunity to engage in physical exploration of his immediate environment improves the infant's skill in handling his whole body apparatus as a means-action instrument. But more focused types of stimulation are required to facilitate verbal ability and fine perceptual-motor, problem-solving skills.

Bayley (1965) reports in the same vein, in a survey of 1409, one-to-fifteen-month-old infants on her scales of mental and motor development.

Comparisons of the infants according to sex, birth order and education of either father or mother, and geographic residence produced no score differences in any of these subgroups. On the other hand, a comparison of the motor test scores of Negro and white babies, showed the Negro children to be consistently advanced over the white infants on 11 of 60 items on the motor scale (with no difference found on the remaining items), principally those which may be defined largely in terms of gross-motor operations of balance and coordination. Similar findings have been reported by other investigators (Knobloch and Pasamanik, 1953; Pasamanik, 1946; and Williams and Scott, 1953). Geber (1962) has postulated that this may be the result of a greater lattitude often found in lower class and Negro children's environments with respect to opportunities for large-motor, physical exploration.

One of the critical issues on stimulation which has long plagued us is the question of timing. The problem of timing is represented by a variety of different concepts and terms, such as "critical period,""learning readiness," and "teachable moment." The central core in these terms is found in the idea that development progresses at a certain rate through a set of sequences of increasing complexity. The level of task difficulty and complexity of concepts presented for learning should not exceed the level of development which a child has attained. These concepts of developmental sequence, which are basically consonant with Piaget's (1952) theories of development, have found experimental support in some studies (Elkind, 1961; Kohlberg, 1962; Wohlwill, 1960) but less in others.(Feigenbaum, 1963; Kofsky, 1966).

Some of the measurement problem apparently relates to the difficulty of devising clear and standard instructions and task arrangements for tasks at different levels to prevent interference with measurement of intrinsic task difficulty. There may also be a limiting condition, however, which cuts across sequential levels of complexity, namely, familiarity with the specific dimensions, concepts and content inherent in any subject area structure (Feigenbaum, 1963; Uzgiris, 1964). As long as the notion of timing is not tied too closely to age, there is a certain reasonableness inherent in this orientation. Unfortunately, although some account has been taken of interest factors and of variations in the quantity and forms of experience accumulated ontogenetically, much of the burden of explanation has been placed upon the "natural" ripening of cortical processes through biologically regulated maturation. Historically, this orientation has long haunted school systems, as if to justify the powerlessness of teachers to alter the mechanical, mass-oriented framework and procedures produced by rigid establishments.

Much current thinking is moving away from the concept of critical ages and periods in the form of rigid, age-associated stages of development to the idea of optimal periods and sequences for gearing stimulation to development. This notion envisions a more powerful and continuing but adaptive function for stimulation, operating interactively in organismic-environmental relations. Individual differences thus come to the foreground, development varying as a product of both biological factors and the cumulative forces of stimulation.

In the 1920's and 30's an extensive series of experiments were carried out on infants and small children, attempting to settle the question of the relative importance of maturation as against learning in development. Many of the experiments carried out by Gesell and others (Dennis and Dennis, 1941; Gesell and Thompson, 1929; Hicks, 1930a and b; Hicks and Ralph, 1931; Hilgard, 1933) did manage to show that the problem of timing bore considerable importance. But there were several constraints in the design of these experiments, as this writer has discussed elsewhere (1962a), which tended to throw into the shadows the importance of stimulation as a force in development. In the late 1920's, Gesell and Thompson (1929) began a study of motor learning as part of a longitudinal investigation of Gesell's famous identical twins T, the trained twin, and C, the controled twin. This study can serve to illustrate these constraints very well.

Beginning at the age of 46 weeks, twin T was given 20 minutes of training in stair-climbing and cube manipulation (including prehension and manipulation of construction play cubes) over a period of six weeks. At the end of this period, twin C proved equal to her trained twin mate, T, in cube behavior, but could not climb five stairs even with assistance, while twin T, by this time, was an expert stair climber. At the end of two more weeks, still without training, twin C could climb to the top of the stairs without assistance, but took 45 seconds compared with about 26 seconds for twin T. Twin C was then given two weeks of training, at the end of which time she could reach the top in ten seconds. Her skill now approached that of twin T.

The prominent position in which Gesell and others have placed maturation in their interpretive framework appears to result from their tendency to ignore several basic restrictions inherent in the design of this type of short-term learning experiment. In the first place, skill ceilings are probably intrinsically low in motor tasks of this order. Even prolonged periods of training probably could not improve performance on these relatively simple tasks, much beyond the competence attained in these short periods. In the second place, while twin T was undergoing specific training, twin C was living in a reasonably normal environment. She had ample opportunity for self-guided exploration and experimentation, termed autogenous sources of learning by Dennis and Dennis (1941). She was presumably acquiring many varieties of experience in object prehension and manipulation through exploratory play, as well as engaging in gross-motor activities. Both of these as well as other related activities would contribute heavily toward the kinds of cognitive. motor competence, namely, learning to use the hands and body as problem-solving instruments, demanded in the specific tasks in which T was being trained.

Actually, the importance of the role of stimulation can only be firmly appreciated when one compares studies carried out on a longitudinal basis. The studies, for example, of Dennis and his co-workers (1957, 1960, 1965) on infants in institutions, understimulated for long periods, who are found to be grossly retarded in gross-motor skills are illustrative. It may not be, as McGraw (1935) was inclined to say, because gross-motor activities and simple tasks are phylogenetically determined but rather that we are accustomed to observing infants develop under conditions of average stimulation over the long pull.

It is interesting to compare the cognitive motor skills of both of Gesell's twins, T and C, with the performance of children reared under average conditions, without the benefit of specifically focused stimulation. In stair-climbing, for example, twins T and C at about one year could climb five stairs alone in approximately ten seconds. According to Gesell's (1947) own developmental norms, the average American child does not typically even creep up stairs until 15 months, walks up with assistance only at 18 months, and walks alone only at two years. Even within the short-term experimental framework of these studies, the investigators, in their stress upon maturational processes, all but ignore the substantial gains that both control and experimental children invariably made as a direct consequence of systematic stimulation.

The relative potency of long- as against short-term follow through efforts at stimulation can best be appreciated by comparing this class of short-term maturation versus learning study with the classic and unique study of twins by McGraw (1935, 1939). Comparisons between the twins were limited methodologically by their fraternal relationship and such factors as partial failure to control for Jimmy's (the control twin's) social isolation. Yet the value of this study as a model is exceptional because of its unusually systematic and longitudinal control of stimulation in the infant period, along with the impressive learning accomplishments of the experimental twin.

Starting at the age of 20 days, the two boys were brought to the laboratory daily, seven hours a day for a period of two years. During each day, Johnny, the experimental twin, participated in about three hours of guided exercise and training per day, while Jimmy was shielded from contact with Johnny. Except for the attentions accompanying routine care, he was left to play with a few toys in his crib.

The training was divided into two classes of activity, one of which was described as phylogenetically based. These consisted of simple reflex or other low-level activities, embracing the Moro reflex, manual prehension, crawling and creeping activities, and other similar, relatively simple, fine- or gross-motor perceptual-cognitive activities. The training in this sphere followed a course of timing more or less according to the expected norms for development of the type of functions in question, new functions being added in each case at about the expected normative period.

Generally speaking, for these simple functions, McGraw found that the added stimulation with Johnny did not materially advance his rates of development beyond those of his fraternal twin or of the group norms of other infants under study. However, McGraw was comparing a stimulated child with norms for children developing under average conditions of stimulation, as against deprived children, for example, such as Dennis (1960) and others have described.

McGraw's findings are at variance with the accelerated development with which B. White and Held's (1966) infants responded to enriched stimulation in visually directed reaching. B. White's subjects were institutionalized infants, however. On the other hand, the discrepancy may also be a function of the more defined and complex analysis of experimental conditions of stimulation undertaken by White right from birth, as well as the longer period in which stimulation was apparently conducted on a particular sensori-motor schemata.

McGraw's experimental program on complex cognitive-motor learning, which she classes as ontogenetic, meaning more controled by cumulative experience, produced more dramatic results. The educational program for these complex skills began for Johnny at the age of seven months, continuing until the twins were approximately 24 months of age. Training for the controled twin, Jimmy, began only at the age of 22 months and continued for only two-and-a-half months. The list of activities in the program embraced swimming, diving, descending and ascending inclines (slides), jumping and climbing off high stools, skating, tricycling and grading and manipulating stools and stacking boxes. At the end of the 22-month training period, Johnny was far superior in mastering all skills compared with his unstimulated twin, Jimmy. Differences were marked even following two-and-a-half months of special training which Jimmy received ~~at~~/from the age of 22 to 24 months.

The effectiveness of the program may be illustrated by the fact that Johnny learned to swim entirely alone, maintaining a horizontal position but remaining submerged six inches below the surface, by the time he was ten months of age. He could then swim across the tank, a distance of about seven feet. He had established some mastery of roller skating on four-wheeled, ball bearing skates between the ages of 13 to 15 months of age. He could climb up a 61-degree incline at the age of 16 months and a 70-degree incline at the age of 22 months. By the age of 15 months, he dove alone off the edge of the pool with much pleasure. At 17 months, he dove similarly from a springboard. His accomplishments were similar in other activities.

This study appears to underscore in a manner almost no other study does, the value of longterm, developmental stimulation programs starting at the earliest infancy. The remarkable achievements of Johnny by the age of two years stand in vivid contrast with the minor achievement differences demonstrated in the short-term learning investigations conducted by Gesell and his followers.

The impact of the early longterm stimulation is further indicated by follow-up measures made on the twins. At the age of six, Johnny generally maintained his advantage in those skills in which he not only had attained a high degree of mastery but also in which the alterations in body structure did not affect his performance because of shifts in equilibrium requirements. He maintained his skill in tricycling and getting off pedestals, for example, but there was a marked deterioration in his skating ability.

The tendency for competence to be lost in certain types of activities underlines the value of continuing training and/or practice on a more or less indefinite basis. There is often a pseudo issue raised in which the test of early stimulation become the pervasiveness of its influence upon all later development. This ignores the problem of forgetting which, as any accomplished musician or speaker of a foreign language can testify, bears some relation to time since previous practice. It is probable, in other words, that while the early months and years of life may be valuable to launch the foundation for later development, stimulation extending even over the first three years cannot carry the entire burden of development. Stimulation must often be pursued over a much longer developmental span in many cognitively complex fields to permit the accrual of large bodies of information, skills and the mastery of concept hierarchies. This point is especially well illustrated in the field of music, as will be shown presently.

Not the least of the findings which emerge from McGraw's prolonged early training study is the power of ~~the~~ early stimulation--presumably including her methods and attitudes--to generate effective and relatively permanent motivational systems, a sense of efficacy (R. White, 1959). At nearly every phase of the training period, there were striking contrasts between the boys in the quality of interest displayed. Johnny consistently demonstrated high self-confidence and enthusiasm as he engaged in the complex motor activities, an attitude which persisted to the later follow-up study at age six. He tended to throw himself into a task, even a new one, wholeheartedly, with little consideration of the risk contingencies. He would also persevere longer than Jimmy in exploring the dimensions of a task in order to work out solutions.

There were, in brief, some sort of generalizing processes at work, a kind of cross-facilitation which not only gained superiority in particular skills for Johnny but led to generally superior muscular coordination and cognitive orientation for learning in the gross-motor sphere. He acquired what may be defined as a general cognitive learning set for gross-motor activities, an orientation and learning to learn. Not only his skill level but the manner in which he handled himself in approaching and engaging in a task was quite superior to his twin, Jimmy. The extent of generalization is indicated, for example, when at the age of 16 months he was taken to a lake for the first time. He dove and swam in the water with little hesitation and much delight after having been limited previously to swimming and diving in a miniature pool seven feet across.

It was evident from this study that motor skills are not simple, mechanical-type operations. They are also cognitive operations. One may conveniently divide these ontogenetic skills into two classes, both of them involving problem-solving. In the first, there is a heavy proportion of dependence upon the body appendages and torso as instruments for accomplishing certain ends. These skills include diving, swimming, jumping, skating and the like. The second form of task required complex skill manipulation of physical objects as well as use of the body as an instrument. Johnny had to manipulate, grade and/or pile stools and boxes in order to reach an object suspended from the ceiling otherwise out of the child's reach.

In the latter activity McGraw attends more explicitly to the cognitive processes and dimensions required of the tasks. She mentions, for example, that as he approached mastery, Johnny would stand off from the randomly placed set of boxes on stools to reflect. His expression clearly indicated he was analyzing the problem before attempting solution. He also became more sensitive to discriminating the concept of height by the age of 15 months, as a result of his training in manipulating and grading these stools and boxes.

By the age of 20 months he was beginning to understand the concept of serial order. At 22 months, he had clearly mastered this concept, grading as many as five heights in a series.

In this regard it is interesting to compare Johnny's accelerated development of the concept of seriation with norms derived from Piaget's studies (Flavell, 1963, page 314). The youngest children, four-year-olds, in Piaget's experiments were unable to arrange objects (dolls) in a series according to height, or to insert a missing doll in its correct ordinal position even after the experimenter had arranged the series of dolls in order.

McGraw also conducted an experiment on memory development, training Johnny to locate hidden objects. After several months of training, Johnny at 24 months, could locate eight unrelated objects, hidden 12 hours earlier, regardless of order in which asked for. His performance was, in fact, considerably superior to the unrehearsed trials of adult observers in the project.

Yet the boundaries of Johnny's competence, compared with his untrained twin, are relatively clear. The demarcation of competence was highlighted by comparing the boys' performances on a variety of fine, perceptual-motor, problem-solving tasks, given to both children at the age of 24 1/2 months. Most of these tasks required the child to discover that sets of sticks or other means could be combined to obtain a lure otherwise out of the child's reach. Although similar in a general way to the stool and box piling tasks, the fine-motor tasks demanded greater precision and more complex reasoning. On these tasks, Johnny was no faster than Jimmy in his rate of learning to solve problems. He was, on the other hand, consistently superior in such general aspects of his cognitive functioning as the amount of searching, exploratory and analytic operations he employed in solving tasks. He was also superior in his ability to make precise size discriminations involved in one of the tasks. He showed a slight and continuing advantage on the Merrill-Palmer and Minnesota preschool scales over his sib. Both children, however, scored somewhat below average norms.

These additional examples of performance discrepancy between gross- and fine-motor spheres of competence would tend to support the notion of cognitive competence as processes partially bounded by or anchored to particular areas and dimensions of activity. There was, in brief, a relative lack of transfer across spheres of activity. This point is further illustrated by Johnny's relatively poor language development compared with norms, as well as the fact that he could make good size discriminations on a non-verbal basis but was poor when using language mediation.

In view of the unique qualities of this study it is worth summarizing certain principles and methods employed in the training program. In addition to the longitudinal plan for stimulation, one of the most outstanding principles of the program was the careful attention McGraw devoted to analysis and grading of the task sequences. Tasks were arranged in terms of levels of complexity, difficulty and logical order, following the natural arrangement of skill and cognitive components of a task. In learning to tricycle, for example, attention was first given to the process of learning to pedal as separate from steering, leaving the latter operation until later.

To teach swimming, the first problem was defined as learning to get the grasp of the dimensions of water. During the first month, with careful guidance, the child learned to accept submersion and how to spit out swallowed water. Attention was then shifted to learning forearm strokes. Each week, the harness around his balance point at the chest was moved a bit further toward the lower torso, making him increasingly, but only very gradually, dependent upon the movement of his upper appendages to hold himself horizontal, as well as to sustain forward motion. Similar kinds of sequential guidance and well-timed and analyzed intervention were provided throughout all of the activities. The training program was, in short, longterm, carefully graded and systematic.

Motivational conditions were handled principally through establishing a well-defined and systematic framework of routines, in which adult expectations for the child to exercise and be guided clearly produced internalized expectations in Johnny to carry out a daily regimen of activity. But it is equally obvious that "forced-feeding" and pressure techniques as such were underplayed. Although the experimenter maintained something of a neutral rather than a praise-oriented attitude, it was clearly an accepting attitude and social framework, in which the child came to anticipate with pleasure and confidence the exercises and achievement learning. The semi-permissive and interest basis used for generating motivations is suggested, for example, by McGraw's practice of concentrating on activities of Johnny's choice on many days.

The motivational system utilized may be described as primarily intrinsic reinforcement, deriving from satisfaction over achievement and mastery, within a framework of social reinforcement--experimenter approval. The orientation incorporated another principle, namely, the constant analytic or cognitive, problem-solving orientation of the experimenter in her approach to teaching. She used a light, guiding hand, with little verbal didacticism, often letting him work out solutions to skill coordination and sequencing. Focus was again and again upon the dimensions and relations involved in a task, perfecting and integrating performances as a consequence of *assessing* and *understanding* task dimensions and sequences.

Finally, the entire program was based upon focused stimulation in specific task learning, nearly all of which concentrated in a single-type sphere, namely, problem-solving in the gross-motor area. The learning of concepts and principles, in other words, was tied to particular contexts and types of perceptual-motor ~~[illegible]~~ learning. Yet this orientation also resulted in considerable cross-fertilization among the tasks, as witnessed by the developmnnt of highly generalized competence, muscular coordination and cognitive orientations toward the gross-motor sphere in general.

The Acquisition of Perceptual-cognitive Structures

Sensory Deprivation. Curiously, awareness of the tremendous value of early stimulation as a vital, if not critical, experience for all subsequent development has found its greatest impetus from studies on its absence, or studies of animals and children deprived of assumed normative levels of stimulation. The study of deprivation is, of course, simply the obverse of the study of acceleration, differing principally in the direction in which stimulation is varied from some assumed norm. The basic problem remains the study of how variation in quantity and type of stimulation *cumulatively* influences the cognitive and personality development of the child.

Interest in this problem was early generated by the pioneering studies of psychoanalytically-oriented workers like Spitz (1945) and Goldfarb (1955), on the one hand, and from Skodak (1939; Skodak and Skeels, 1945) and Skeels (1942; Skeels and Dye, 1939), Kirk (1958) and others, who were interested in broad scale intellectual differences in development. The prevailing consequences of early deprivation have been apathy or heightened social attention-seeking (Casler, 1961; Yarrow, 1961) and depressed intellectual functioning as measured by IQ tests. In one of the few, better controled studies confined to the infant period, Gilliland (1949) compared IQ scores of 300 home reared with 300 institutionally reared six- to 12-week-old infants. On 18 of the 40 items of the Northwestern Infant Intelligence Test relating to social and physical contact, as well as on mean test scores, institutional (presumably deprived) infants performed significantly lower than home-reared infants.

Those psychodynamically oriented have placed the burden upon maternal deprivation, while Kirk, Skodak and Skeels and others have placed greater weight upon the impoverishment of intellectual stimulation. Yarrow (1961, 1965), stresses the importance of distinguishing between various forms of early experience, especially, social, affective and sensory stimulation but accords no independent role to cognition. Experimental studies of sensory or perceptual and social deprivation have largely overlooked questions of cognition in defining experimental tasks and measures, except for the empirically developed, global-type IQ measures (Fowler, 1966).

There also has been little inclination, until recently, to look at the cognitive dimensions of social development. Social development as a cognitive process has been defined by Piaget (1948) and elaborated by Kohlberg (1963) and Baldwin (1965). The concept "social," in particular may be thought of as simply one area of experience, varying in the amount of perceptual-cognitive complexity involved, much as does experience in any area of the "thing" world of inanimate objects. In the same manner, the proportions of intuitive as compared to symbolic functioning in the social sphere, varies as does our commerce in any other sphere of reality. Unfortunately, our assessment of social cognitions historically have been diluted through burial in global IQ measures or confined to sets of observations which have defined social functioning in opposition to perceptual-cognitive processes.

Early perceptual and social stimulus deprivation has been experimentally explored widely on the animal level through the work of Hebb (1947, 1949), Scott (1963) and others on dogs reared in social isolation and confinement. Riesen (1947, 1960) has studied visual deprivation in monkeys reared in varying degrees of darkness and Harlow and associates (1960, 1962) and others (e.g., Green and Gordon, 1964) have studied the effects of early and protracted stimulus deprivation extensively over a range of social and sensory variables, such as tactile stimulation and peer and maternal experience. On the limited visual deprivation research on humans, congenitally blind infants who later regained their vision through surgical intervention, proved to have defective pattern vision (Senden, 1960). They required prolonged visual experience to attain levels which remained even then below norms.

Despite the confusions which have beset the study of stimulus deprivation (and acceleration) collective effort in this field has yielded some quite provocative longitudinal findings. Consistently, in animals, there has been a rather direct relationship between the type, extent and earliness of the sensori-cognitive deprivation and the form and extent of depression of functional development. In humans, when measures are made of sensory, social or IQ changes with experience in comparatively shortrun periods of two- to three years, the typical mean IQ (and other) differences ~~gains~~ of five- to ten or more points, even when significantly ~~greater~~ different than controls, have seldom been startling given the usual problems of methodological control. It is only when we expend our horizons to check the cumulative consequences of gross differences in experience over long time arcs of development that resulting contrasts between experimental and control subjects become more dramatic.

There are two particularly noteworthy investigations of this order. We have first, the ~~valuable~~ data by Newman, Freeman and Holzinger (1937) on identical twins, separated between the ages of two weeks and six years. The most significant finding (sometimes obscured by the later similarity in IQ scores found in many of the twin pairs, despite separation) is presented by Woodworth (1941) who, combining this with additional data on separated twins, found a correlation of .79 between the amount of educational difference and the IQ differences between adult twins.

The second, a truly longitudinal and controled study (Skeels, 1965) of the cumulative consequences of stimulus deprivation, contains rather startling results. After a lapse of 21 years, all 25 adult members of Skeels and Dye's (1939) original study of (functionally) mentally retarded, institutionalized infants have been located. At an early age, 13 experimental group infants were transferred to another institution, where they were placed in the care of mentally retarded mother-surrogates in a one-to-one relationship. The latter are reported to have identified with and devoted themselves wholeheartedly to the mothering role. At later points, 11 of the 13 were placed in adoptive homes, while all 12 control group children remained in a nonstimulating institutional environment over many years. Now, as adults, the median educational levels reached by the experimental group is 12th grade (four having some college) compared to the third grade for controls. Occupationally, all 13 experimental subjects are self-supporting in jobs ranging from semi-skilled labor to professional. Only 50 per cent of the controls are unemployed, one died and, of the balance, only one is employed above the level of unskilled labor. Four are still institutionalized. Maritally, 11 of 13 of the experimental subjects are married, and nine have children. Only two of the controls have married and one of these is divorced. While follow-up IQ comparisons are not reported, these findings on intellectual and social achievement and competence are vivid testimony to the importance of experience--however defined in and to the drama inherent in longitudinal experimentation.

Accelerated Stimulation. Much of the lore of the nursery school and infant development, as well as both the earlier developmental theories of Gesell and the currently popular cognitive developmental theories of Piaget, define infant cognition in terms of sensori-motor functions. One of the main aims of this chapter is to analyze experimental evidence so as to set in relief the cognitive dimensions of early learning processes, a period in which language mediational processes are clearly secondary. In an interesting collection of experimental investigations in the USSR, Koltsova (1960, 1962) and her colleagues have been studying in intimate detail the effect of motor mediation upon the development of cognitive processes in one- and two-year-old children. In one type of experiment (1960), she finds that children, whose instruction in a verbal task, e.g., "Give me the doll," is set in a framework demanding a wide variety of motor acts, learn to generalize in a test situation to a criterion of 80 to 90 per cent. This compares with no generalization evident for children who learn verbal instructions in the context of only one or two motor acts. In another similar experiment (1962), she finds that classificatory concept labels of a genus-species type are learned more readily when accompanied by conditioning in tactile, visual, auditory and kinaesthetic-proprioceptive modes than with when acquired on a verbal level alone.

Another Soviet investigator, Lyamina (1958), on the other hand, reports that children of this age can be taught object labels more easily when *not* engaged in motor activities with the objects. She found considerable conflict for children in coordinating behavior in the two spheres, until walking and other motor learnings are well mastered, a finding which corresponds with Shirley's (1933) earlier work. According to Lyamina, the important variable to facilitate learning is to capture the child's attention through novelty. The importance of novelty in curiosity motivation is increasingly emphasized in many studies (Fiske and Maddi, 1961, Lucco, 1965).

In a related line of work Luria (1961) reports that children of less than 16 months of age cannot inhibit a motor act (such as placing rings on a peg) on the basis of verbal instructions alone, which appears to support Lyamina's observations on learning conflicts between the two spheres in the infant period of development. Once the activity is begun, instructions to stop usually result in the infant increasing his rate of performance. Such contradictions between sets of findings may be a consequence of differences in experimental conditions. This investigator observed some slowness in the initial phase of language learning which paralleled the period when his daughter, Velia, was acquiring her basic gross-motor mobility skills (Fowler, unpublished study). (The study is summarized in the next section.) On the other hand, a slow pace is also characteristic of most learning in the beginning period.

But aside from raising questons of the relations between motor mediation and concept learning, Koltsova's studies establish rather firmly on experimental grounds the one-year-old's rudimentary potential for classificatory concept learning. On the basis of verbal cues (The question of the role of motor participation apparently remains unresolved) the one-year-old can learn to sort objects according to type, to place balls and blocks together, for example, as member of the genus or class, "toy."

The success of Koltsova (1960, 1962) in developing definite sorting behavior with verbal concept labels is less surprising when seen in the light of a series of studies by Ricciuti (1965; Ricciuti and Johnson, 1965). The latter observed that infants as young as 12 months of age could selectively order (in their order of handling) geometric forms of a single subset, when the forms also varied in color and other tactile cues. In a few instances infants grouped all four members of a subset into an object grouping. Infants were given loose verbal instructions "to play with" objects or "to fix them all up." It was not until 18 months that infants could sort the members of two subsets into distinct groups. Categorizing behavior improved with age, but Ricciuti reports a parallel counter tendency of older infants to build more configurational groupings, as Piaget (1952) claims. One interpretation possible is to see the latter orientations as the root of open-ended, construction or synthesizing cognitive styles, a cognitive function probably ~~of~~ equal in value to analytic-classificatory-abstracting styles and probably important in the development of creativity. This varies from the Piaget (1952) and Kohlberg (1962) conception of cognitive development, in which levels of complexity are placed in a single, sequential scale of development.

There are very few studies on early development where an effort was made to facilitate the emergence of classificatory structures on a longitudinal basis. Looking back to the first year of life, these kinds of cognitive operations can possibly be traced to the first establishment of object permanence and dimensional constancies of size, form and the like. Wohlwill's (1960) survey of studies of perceptual development finds something of a confused and incomplete array of investigations on these problems. Nevertheless, Misumi (1951) presents good evidence for size constancy by nine months and recent experiments by Bower (1966) suggest that size and/shape constancy can begin as early as 40 to 70 and 50 to 60 days of age, respectively.

In nearly all of these studies, investigators have confined themselves to measures of infants (and children) at different ages, without regard to the infant's prior experience. Much of these data reported, therefore, lose value as indices of norms for perceptual-cognitive development in the face of the stimulation studies of Ling(1941), Welch (1939 a, b, and c) and McGraw (1935).

The significance of the investigations of all three experimenters lies principally in their bringing under a degree of experimental control sets of stimulus sequences which were successful in producing the perceptual operational basis for accelerating concept development. The issue is not merely one of accelerating cognitive development, therefore, but of discovering the kinds of arrangements of perceptual conditions which will enable us to plan for and regulate development on an optimal basis.

In Ling's (1941) investigation, (described earlier) infants between the ages of six and 13 months apparently acquired stable concepts of abstract form with three-dimensional objects. The infants learned through persistent stimulation in the setting of a carefully programed set of experimental conditions continued over several hundred trials. Similarly, Welch developed refined discriminations of size (1939 b and c) and area (1939a) in infants between 12 and 28 months of age by means of repeated stimulation over many months. Gross size discriminations between boxes became evident early, right at 12 months, while gross form and area discrimination of a set of wooden plates appeared by 14 months. Refined discriminations of form and area of the order of 1/2 inch differences in the various dimensions were attained by some infants by the age of 28 months. The training group mean at 27 months reached a level (discriminations of approximately one inch) not attained by controls until 57 to 60 months of age.

In another longitudinal investigation of early stimulation, Welch (1940) undertook to teach hierarchical concepts, that is, genus-species relations, through a six months' daily program to infants between 12 and 20 months of age. The success of Koltsova (1962) in generating classificatory concepts, compared to Welch's confession that his program produced little beyond tired motivations, supports the value of the rich and varied, motor involvement employed by Koltsova as an underpinning of cognitive stimulation programs during the early years. The difference in their results also tends to confirm the importance of novelty in facilitating learning. The stimulation framework utilized by Welch suggests a rigid, drill-like approach, which could have been altered in many ways to prevent monotony.

The structuring of experimental conditions within a means-end task or problem-solving framework as McGraw (1935, 1939) and Ling (1941) did is apparently one satisfactory technique. Correct choices in each investigation led the infant to a reward, saccharine coated forms for Ling and attainment of goal height for Johnny. Moreover, in the latter experiment the experimental task provided a highly and continually active role for the child, both in sensori-motor and decision-making terms.

The use of play-oriented methods is another foundation for successful stimulation programs with infants and young children. Play-activity techniques have been most productive for motivating learning in programs historically (Fowler, 1962a) and in a few experimental programs xx we shall describe presently (Fowler, 1965a).

The research findings of Koltsova (1962), Ling (1941) and even the observations of Ricciuti (1965) do not easily lend themselves to Piaget's notions of natural sequences in which cognitive structures supposedly get developed. Piaget (1952), for example, sees the central representation of objects or object permanence developing through a process of repeated encounters with a variety of objects, in which increasingly wider visual displacements in space and time culminate in a stable concept during the second year of life; for his own children this was around 18 months of age. While Piaget himself recognizes an important role for experience and hence puts no great store on age linkages, his concepts depend upon a general order for the development of structures. Moreover, he talks very little about individual differences in developmental timing as a function of cumulative differences in learning.

An equallly focal question is how determining and pervasive central structures are. Are concepts acquired, for instance, only in the context of particular content spheres or dimensions? This would mean that a child's conceptual powers are initially not equally developed in all "compartments" of the general apparatus of the mind--at least until he had learned similar concepts across a range of spheres. It would not be until this point, at some later period of development, that sufficient transfer or generalization could occur to produce a higher, general level of cognitive functioning. Koltsova's ability to ~~develop~~ induce the beginnings of classificatory concepts in infants several years before the expected age period of "concrete operations" (which develop from about ages four to seven according to Piaget) and even Ricciuti's disclosure of two types of sorting behavior in infants suggest that the picture may be quite complex. Development appears less uniform, even and general with respect to the emergence of cognitive processing systems than Piaget's (1952) theories would imply. Uzgiris (1964) (Bing, 1963; Feigenbaum, 1963; Halpern, 1966; Kofsky, 1966) have frequently observed that children vary in the stability of their concepts of conservation according to differences in the nature of the material and tasks employed. Similarly, McGraw's investigation revealed that Johnny was quite cognitive, a good problem-solver, when operating in the large scale ~~of~~ macrosphere of gross-motor objects, whether using his own body or other sets of objects as the instruments. Yet these kinds of means-end efficiencies carried over poorly to the fine-grained, means-end sphere of problem-solving upon which IQ measures and other related tasks are constructed, whether non-verbal or verbal in form. There are apparently limits to the degree of transfer of function defined in some way by the degree of relatedness among spheres.

Symbolic Mediation and Structures

Language mediational structures are being assigned an increasingly pivotal role in the operation of human thought processes. Vygotsky (1962) and Luria (1961) are among those who grant the greatest power to language systems in the development of cognitive functioning. Although these writers accord some function to non-verbal problem-solving processes in the beginning years of life, they see the magnitude of human thought only realized in proportion as the individual develops a conceptual apparatus based on complex, abstract symbol systems. It is through the vehicle of such a coding system that the individual is enabled to represent the natural world in all its variety and complexity.

But the individual does not respond to the world in a random, chaotic fashion. He acts upon it and develops varied problem-solving strategies in order to accomplish certain ends in a highly selective manner. The abstracting, grouping operations of language concepts permit him, not only to master the world as he finds it, but to build new realities in the form of inventions. He constructs original conceptual structures to design new realities in many forms with the very substance of language as a tool.

Verbal language processes have another key function. They serve to guide and regulate the individual in his own problem-solving behaviors and actions as he relates to and acts upon the social and physical world. In brief, language serves as a feed-back mechanism. In the earliest stages of language development this appears in the form of external or egocentric speech, as Piaget calls it. Later, speech becomes internalized and represented in an increasingly shorthand form, but still guiding the individual through internal, symbolic mediation in his everyday behavior as well as in his abstracting, constructing processes.

Piaget does not ascribe so central a role for the function of language processes even for the later development of the high level cognitive structures of adolescence and adulthood (Flavell, 1963). He seems to define a greater separation of thought and language. From his investigations, Furth (1964) concludes that high problem-solving abilities can be developed by deaf-mutes in the absence of (ordinary) language systems. But the form for abstracting in this pattern of development may rest on alternate symbolic systems, such as gestural, language communications systems. Indeed the contemporary educational system widely applied to deaf-mutes is regularly based on our alphabetic language system transmitted through the vehicle of finger and hand manipulations.

The areas of knowledge and the cognitive processing operations involved in the domains we term musical and mathematical may be also conveniently conceptualized as language systems. Both of these spheres are constructed in the form of complicated symbolic structures. They are systems of abstraction with specialized notational systems making use of symbols from the common language only on an ancillary basis. Among functions which they share in common with ordinary verbal language are the property of representing selectively the organized features and processes of reality. All language systems are also symbolic structures with an internal logic and organization of their own. They are constructed in a framework of rules and relationships which are relatively independent of the actualities of the real world. One of the prime functions of mathematical systems, in particular, is its enhanced power for furnishing shorthand devices for representing and measuring the complex structures and processes of the world. Thus the calculus, for example, is an extremely precise, logical system of notation for describing rates at which processes change.

All language systems share an additional property, a property which characterizes all systems of aesthetics, to which we may add here the plastic and other visual arts as well as the musical idiom. This additional property has to do with formal qualities and relationships intrinsic to design and color function. In addition to their representational and logical characteristics, formal qualities partake of certain psychological and sociological characteristics which we come to relate to concepts of beauty. This aspect is also deeply enmeshed in common language systems, defined characteristically as the realms of literature and poetry. These reflect the rhythmic styles and psychological nuances which the individual attaches affectively to language form, as well as to the particular manner in which language characterizes and projects the cultural idiom and societal structures. The world of mathematics, too, shares formal qualities from which, persons who become immersed and versed in this world, derive an aesthetic as well as cognitive experience.

It is evident that language functioning permeates in some way nearly every aspect of our cognitive processes. Language functioning is not an isolated aspect of human functioning which can be sequestered in an intellectual vacuum apart from the problems and processes of life and development as a whole.

The concept of structure in language processes is being widely studied by psycholinguists, boosted by the occasion of Chomsky's (1957) model for the generation of syntactic structures. His model has so highlighted the system properties of language as to open to question reinforcement and imitation as bases for theories of language learning (Bellugi and Brown, 1964; Ervin, 1963; Menyuk, 1964; Slobin, 1965b). Yet, as some investigators are beginning to realize, we need not entirely eliminate learning and imitation as mechanisms for language development (Slobin, 1965b). We simply need to generate a far more complex model for language learning. We must devise a model which takes account of system principles in the acquisition of language structures, rather than relying on a straight-line, linear accretion model, the model which has tended to form the framework of traditional stimulus-response learning theories.

As in other spheres of learning there are comparatively few longitudinal studies of language learning which use any model at all of the nature of language development. Currently, a great deal of effort is being devoted to tracing the developmental emergence of language structures. Several investigators are making fine-grain analyses of detailed, longitudinal observations of the sequences of language development, based on a miniature sample of children (Bellugi and Brown, 1964; Casden, 1966). Given the recency of our concern for the structures of language and the limited information available on their development, it may well be that efficient attempts to gain control over the progress of language development must attend upon the collection of more developmental description.

As we know from many normative studies (McCarthy, 1954), the period between eight and 12 months is evidently a highly involved period, preparatory to the greater reliance upon language processes during the second year. During this period, meaningful word emissions come into play, starting shortly after one year of age normatively. In the USSR, El'konin (1960), for example, has shown that seven- to eight-month-old infants discriminate poorly, if at all, vocal from other forms of auditory stimuli. Yet by the age of 10 to 11 months, infants show conditioning rates to word stimuli four times faster than to other forms of auditory stimuli.

Rheingold (1956, 1961; Rheingold, Gewirtz, and Ross, 1959), Weisberg (1963) and others have shown that some experimental control of stimulation of children's vocalizations can be established in three-month-old infants. Both social and non-social forms of stimulation (reinforcement) conditions have been successfully applied to increase the frequncy of infant vocalization.

These are all short-term learning studies, however, which fail to provide much information on the cumulative influence which may result from stimulation applied systematically over long time spans. Some small indication of other kinds stimulus conditions which may enhance language learning appear in a study by Bishop (1960). Bishop studied the correlation of selected types of mother-infant interaction with infants at 8.7 and 10 months of age. She found positive correlations between the amount of infant babbling and certain style characteristics of the mother, namely, the amount of verbalization and physical contact, but especially the opportunity the mother gave the infant to explore his environment. Negatively correlated with the amount of infant babbling were suppressive attitudes of the mother. The findings in this preliminary study must be taken with caution since there was low reliability in the frequency of infant babbling across ages.

Following the same general concern and design which governed other maturation versus learning studies of the period, Strayer (1930) undertook to study the effect of the timing of stimulation upon language development. She studied Gesell's [illegible] identical twins T and C when they were approximately 17 to 19 months of age. At this point, the twins were just getting well launched in language vocabulary learning, being slightly behind cultural norms. In this instance, twin T was given five weeks of training at the age of 84 weeks, while her identical, control twin C was kept in a deprived language environment. At the end of this five-week period, when the twins were 89 weeks of age, the roles were reversed. Twin C was given four weeks of language stimulation, consisting of guidance in object label learning, carrying out simple commissions and other verbal instructions.

Again, at first glance, the experiment appears to favor the maturational hypotheses Gesell and his students were attempting to demonstrate experimentally. Starting when the twins were five weeks older, twin C did learn faster. She learned at a rate of 1.074 words per day, compared to .0936 words per day for twin T, for the first 29 words that each twin learned. But this is a difference of no more than .038 words per day. Gesell and Thompson also report elsewhere (1941) that twin C (the control) was more socially responsive than twin T, as well as more vocal as an infant and articulate in language as a child.

Methodologically, however, there are additional considerations which curb the import of Strayer's maturational interpretations. Contrary to Strayer's stated aims, her study does demonstrate the utility of guided language stimulation as a direct influence upon the acquisition of language. During their respective training periods, each twin gained substantially in vocabulary as a result of stimulation, while her control lagged. Taking a broader perspective, the really interesting question concerns how either twin T or C would have evolved in language competence had either received language stimulation for several years, while the other remained in a deprived or "neutral" environment. An experiment of this order would position the forces of stimulation and maturation in a more balanced relationship.

There are a number of studies which relate stimulation to various features of language development in the early months of life, but little in the way of longterm studies of language accumulation. Among Soviet investigators, Lyamina (1960) found it difficult to gain experimental control over language stimulation in children below 16 months of age. On the other hand, Mallitskaya (1960) has devised techniques with which she effected object-word label learning in infants from nine to 17 months of age. The techniques are based on play manipulation and discrimination activities, using pictures pasted on cubes. She found that "by 11 to 12 months of age (children) could generally learn a new word after two or three repetitions and could easily differentiate and find eight different pictures on two cubes." (Slobin, 1965a, page 21).

As we reported in a previous section, the effectiveness of motor mediation as an agent to facilitate concept learning has been explored by several experimenters. Koltsova (1958, 1962) found that one- to two-year-old infants proved responsive to verbal concept learning when learning tasks were accompanied by motor participation. Lyamina (1958), in contrast, reports that motor mediation was an inhibiting rather than a facilitating agent for language learning, a finding which parallels Shirley's (1931, 1933) earlier observations. Shirley observed a tendency for speech development to lag in infants during the most active phases of learning to walk, a finding uncertain in this writer's observations (Fowler, unpublished study).

One resolution of this conflict (other than differences in experimental methods) may lie in the sequential shift reported by Luria (1961) from his extensive investigations on the role of speech in the development of cognitive processes. This developmental shift corresponds roughly to Piaget's (1952) formulations on sequences of development for cognitive processes. Luria's research indicates that motor mediation appears to occupy the master role in infants below the age of 16 months. After this age, language begins to assume a greater role in the organization and regulation of means-end systems of action. There is a gradual enhancement of language mediational control through a series of stages, beginning with the infant's own speech serving as a verbal signal. Later stages involve a shift from responding to verbal statements as signals to responding on the basis of meaning. Another transition encompasses a shift from externalized to internalized speech, in which coding forms become generally abbreviated.

In this connection, it is interesting to compare the relative success of Johnny in the use of non-verbal, problem-solving techniques in discrimination activities with his lack of success with verbal mediation during the period of the experimental training program. Since Johnny had no special language stimulation--and the duration of Luria's training programs are not clear--the 16-month "critical" age period may be something of an artificial norm.

There are two studies which relate the influence of early language stimulation to the production of phonemic patterns in infants. In one of these, Irwin (1960) set up a program in which working class mothers were instructed to read from illustrated baby books, 15 minutes daily, to their infants between the ages of 13 and 30 months of age. The mothers were urged to point out objects in the pictures, name them, make up stories and engage frequently in conversation with their children. After 18 months of age, the difference in the amount of phoneme frequency between the two groups was significantly in favor of the experimental group over comparable control groups.

In something of a parallel study by Shvarchkin in the Soviet Union (cited by Ervin and Miller, 1963, page 111), infants between 11 and 22 months of age were systematically presented with Russian words varying only one phoneme at a time. The phonemic features were learned in a planned sequence that began with vowel training. By the end of the program the children could distinguish the entire range of Russian language phonemes.

About the only documented, longitudinal investigation of syntactical, language stimulation in infants known to this writer is a study carried out by the writer himself with one of his daughters (Fowler, unpublished study). This study took the form of a series of observations of the influence on language development from planned stimulation over the first two years of life. It forms part of a larger study of cognitive development of which one section on early reading is reported in a monograph (Fowler, 1962b). Beginning in Velia's first few days of life, this investigator and his wife set up a program of general cognitive stimulation in which language stimulation was a central focus.

Although there was no clearly conceptualized program of language structure and sequences, the program was aimed in two directions. One of these consisted of relating language word concepts and instructions to the dimensions of the social and physical world in which the child was developing; the other followed a course of language communication in everyday actions, as well as through presentation of poetry, stories and other literary experiences and language games. The second aim was to develop an enrichment of language processes and structures per se. Language-reality association learning was carried out both in play with the child with various educational toys and with objects in the environment. Associational activities were also liberally infused in the daily routine, care-taking operations with Velia.

While few systematic records were maintained, certain observations shed some light on the effectiveness of this kind of language stimulation program in accelerating children's language development. Velia's first two meaningful words, both enunciated the same day at the age of eight months, were "ball and "dog." They were elicited in response to appropriate stimuli. During the ensuing weeks her rate of word-learning progressed slowly, acquiring a few more words by one year, when a spurt was noted. This slower pace could have been related to interference from the gross-motor learning (walking) in ascendance between nine to 12 months or simply a reflection of an average learning curve. At the age of 14 months, her vocabulary had mounted to approximately 100 words; at 15 months, 200 words, expanding geometrically from this point on. She was observed to construct two-word sentences by 14 months, followed shortly after by three-word units. Sentences four to eight words in length were common by the age of 18 months with compound sentence formation of ten- to 15-word units frequently produced.

As might be expected, her vocabulary production was rich, varied and complex. She maintained a steady and elaborated flow of speech in the course of both her endless, independent play and social interaction with peers or parents. Speech was unusually clear and sentences complete, the only consistent pronunciation error recorded was her regular substitution of the "f" and "v" sounds for "th" and "ŧh," respectively. The influence of the cumulative language stimulation program may best be gauged by a comparison with norms. The average child pronounces his first meaningful word typically at about 12 months or more, while a mean sentence length of 1.5 words for the average girl and 3.9 words for bright girls is not achieved until 18 months (McCarthy, 1954).

A longitudinal, experimental investigation on a single child, of course, however carefully conducted and measured, can at best be of no more than heuristic value. The obvious hypothesis that comes to mind, for example, is that Velia was "gifted," a biologically advantaged child to begin with. She was bestowed with a high intellectual potential which, under ordinary conditions of middle-class child rearing, might have matured in about the same way and rate as she did under the focused stimulation program. The fact of high abilities is born out by her continuing high IQ (within the range of 140 to 170 from the age of two on) and superior school achievement up to her current age and grade of 12 and 8th grade, respectively.

However, although documented longitudinal investigations on early speech learning are rare, this is not an isolated study on early stimulation. We have already described the few systematic investigations conducted on non-verbal, problem-solving and perceptual-cognitive learning by Koltsova (1960, 1962), McGraw (1935), B. White et al (1964, 1966) and others. There is, additionally, a vast body of historical and contemporary literature on developmental learning of complex lingua-cognitive processes in so-called "gifted" children. Although most of this material consists of survey analyses and/or sets of observations in case study form or is derived from biographical material, the findings are nevertheless provocative. The term "gifted" is in itself and in persistent usage something of an historical anachronism (Fowler, 1963). It is a label that stresses the magical or biological origins of superior intellectual ability. It ignores the role of experience in the realization of any innate potential, which all studies of bright children suggest is indispensable (Fowler, 1962a).

The evidence from these sources may be regarded in two ways. We shall first concentrate on studies which focus on the first 18 months of life and which are, therefore, more directly relevant to the purview of this chapter. We may then examine these and other investigations, which extend to or have implications for subsequent development.

Many studies on bright children, while affirming that generous portions of stimulation were built into the infant period of development, furnish few details on the nature and methods of stimulation and only the barest summary of developmental competencies. Curiously, almost the only detailed data on the infant phase is focused on the acquisition of graphic language skills, that is, early reading. Reports on learning speech skills or early learning in other language systems are suggestive but short on detail.

Surveys on the early life of accomplished musicians are replete with signs that a rich, informal musical language environment was basic to the home and community in which they developed (Barlow, 1951; Bowerman, 1947; Fowler, 1962a; Maazel, 1950). There are indications, not only that formal instruction often began between two to six years of age, as in the case of Berkova, Heifetz, Menuhin and Mozart, for example, but that there was much intensive incidental stimulation present very early in their homes. Their experience was rich in musical plays and in singing and listening activities of a more or less informal variety from the earliest periods. One formal record mentions a child who could hum tunes at 12 months and sang publicly at the age of four (Gaw, 1922). Starting piano lessons regularly at five, she later became a concert piano accompanist.

Narratives on the early experience of skilled mathematicians are similarly encouraging though sparse. A number of records indicate some calculating ability learned as early as three and possibly two years of age (Barlow, 1951; Bell, 1937; Fowler, 1962a; Scripture, 1891). The early experience of the later great mathematicians and mathematical prodigies seems to have involved high competence in mental operations prior to much if any familiarity with the written symbol. Learning appears to have developed through informal tasks and play situations rooted primarily in counting operations with pebbles, piles of peas or other seeds, and the like.

In the areas of mathematical and musical development, there is a deviant known as "idiot savant." (Anastasi, 1958; Fowler, 1962a). It may be described as highly uneven but precocious development of calculating and/or musical abilities with little high level mathematical or musical conceptualization. The phenomenon is strangely accompanied by poor development of abilities in other spheres of knowledge and functioning. Whether or not there is any biological or organic basis or emotional involvement, as sometimes believed (Scheerer, Rothman and Goldstein, 1945), the early life of these deviants is marked by intense family interest in the phenomena. There appears to be a form of highly reinforced social role carved out by the family to contribute toward the development of overfocused precocity.

Data on the cognitive development of the intellectually "gifted" often reveals an unusual proportion of high ability in one particular sphere of language such as in music or mathematics (Fowler, 1962a). On the other hand, precocious development in one language system has not necessarily precluded exceptional competence in several spheres of knowledge. Historically, in fact, highly developed, well-rounded ability in many areas and functions of knowledge and activity have been the rule (Miles, 1954; Terman et al, 1925, 1940a and b, 1947; and Witty, 1930, 1940).

For some reason, historically, reading has often been viewed as primarily a perceptual learning process. This may have something to do with the fact that the average child is not customarily exposed to reading before he is between five to seven years old. By this age, he has probably acquired certain basic classes of concept functioning, which minimize the number of new concepts he must acquire to learn the graphic decoding system. It probably also is related to the fact that, in learning our written language code, once certain key concepts and principles are mastered, the process is largely one of acquiring an increasing number of particular percepts, using the basic concepts and principles.

These basic concepts and principles include learning to sequence from left-to-right, learning to relate oral and visual stimuli in unit-for-unit correspondence, learning the type and grouping patterns of our complicated phonemic-graphemic relationship system, and learning to synthesize meaning from successions of complicated patterns of visual stimulus sequence units. In various ways, many of these cognitive operations are probably learned early in the course of ordering all kinds of phenomena, including oral language processes themselves. By school age, therefore, learning to read is largely a process of relating basic conceptual structures and processing styles to the graphic coding system and collecting written perceptual units, as opposed to learning a whole new conceptual scheme.

On the other hand, when reading stimulation is started with infants, as it sometimes is at one to two years of age, there is undoubtedly a problem in mastering some of these very basic language and related concepts in the process.

Possibly as a consequence of the frequency and thoroughness with which language and the written symbol pervade ordinary life, reading is often a corrolary and the earliest index of precocious mental development in children. The literature on intellectual giants abounds with cases of children learning to read between two to five years of age. Virtually no well-documented instances are reported, however, in which children become fluent readers (in the full sense of deriving meaning from sentences and paragraphs of written language) with less than an estimated mental age of four years (Davidson 1931; Fowler, 1962a, 1966).

This writer carried out a study on early reading with socially disadvantaged three-year-old, Negro and white identical twins and triplets, using a carefully graded and positively motivating program. The children, who scored below this minimum Binet mental age level, were also children who could not perform certain cognitive integrative and synthesizing operations which are essential to the conceptual coordinating and sequential operations involved in reading. They were able to learn a number of individual words and graphemic symbols but could not deal with them integratively in groups.(Fowler, 1965b).

At the infant level there are numerous cases in the literature which describe children who mastered the entire alphabet, both capitals and lower case letters, by 18 to 20 months of age (Dolbear, 1912; Fowler, 1962b; Root, 1921; Terman, 1918). In three of the most completely reported instances (Fowler, 1962a; Stoner, 1914; Terman, 1918) the infants had learned both capital and lower case letters at approximately 20 months of age or earlier. Stoner's child, Winifred, was reported to have begun simple reading and could do some spelling as early as 16 months of age and to be able to write to some degree by two years of age. She is described as quite proficient in these various skills and was learning to typewrite by the age of three.

Terman's case of Martha indicated a 35-word reading vocabulary and the beginnings of comprehension at approximately 21 months. She was commencing to take pleasure in reading and had a vocabulary of 150 words at about 23 months. Substantially fluent reading, based on a vocabulary of 700 words and coverage of 4 1/2 primers, was attained by 26 1/2 months of age.

The program with Velia, this writer's child, who had earlier participated in a language stimulation program (reported above), produced an accumulated, word recognition vocabulary of approximately 250 words by the age of slightly more than 2 1/2 years. On any given day the child could comfortably identify 20 to 30 words not exposed for a mean of 18 1/2 days with a level of reliability of 87.3 per cent. She was beginning to read primer texts and regularly read with understanding several two- to five-word typed sentences each day.

Both Fowler's child and Terman's Martha were initiated in graphic symbol learning at about the age of 14 months, while Winifred Stoner was presented with an array of written symbol combinations on sides of her crib and walls of her nursery from the age of about six months on. Both Terman and Fowler report a lag of about four or five months before more than a very few (that is, about three to five) letter symbols, could be reliably recognized. Both investigators report the sudden emergence of what appeared to be a generalization, which facilitated learning of the entire set of capital and lower case letters at the ages of about 18 to 20 months, or within the space of one to two months.

This kind of spurt in learning rates is often characteristic, as we have reported on Velia's earlier language learning. It was particularly noted by McGraw in the irregularity with which the experimental twin, Johnny, learned at various phases of his developmental learning program. Learning, in other words, even in earliest infancy and childhood, does not follow a linear course. Many small and apparently insignificant perceptual cues must be acquired and

and assembled in a certain way to result in a new concept or generalization. In turn, this new generalization involving, say, in this instance, the general process of how to make predictable identifications of graphic letter forms, then leads to a rapid learning of all exemplars of the type.

There is a regularity with which the literature reports that infants, who are early stimulated in graphic symbol learning master full recognition of the alphabet at about the age of 18 months. This recalls to mind Luria's finding on the shift in infant ability from motor to verbally mediated inhibition at around the age of 16 months. On the other hand, we have too little information on the developmental background of Luria's subjects. It is also not clear how requiring an infant to inhibit an ongoing motor action in response to oral instructions (the task Luria used) can be compared with respect to the task of recognizing individual graphic symbols.

The methods employed by all three investigators were in many ways comparable, although more elaborated and conceptualized by this writer (Fowler, 1962b). Generally speaking, all stimulation took place in rather brief sessions of a few minutes or more, interspersed throughout the course of a day in a setting of family routines in the home. Motivational systems were founded on principles of using novelty and play-game and problem-solving orientations. Many forms of dramatic and social role-play activities and search-and-find and targeting games were employed. Reinforcement was also based upon close, warm and accepting relationships with one of the parents. For the most part, each child's motivations were high and continuing. Down periods were usually associated with the parent slipping into a drill-type orientation, becoming over-directive and didactic or impatient when a new and more difficult concept was less quickly grasped by the child. Written letter and word and sentence symbols were typically presented in analytic-synthesizing tasks to facilitate focus on structural relations, as well as to embed learning in sensori-motor operations. Finally, the longterm, developmental learning of all three children was generally high, both intellectually and in terms of a broad gauge development of interest in a variety of activities. Each child also acquired some special interest in creative writing as well as intensive interest in reading.

Overview of Issues and Concepts: Developmental Perspectives

Throughout our presentation in this chapter we have been operating with two major orientations toward developmental perspectives. The primary focus has been upon the role of stimulation in infant development during the first 18 months of life. Yet it has been unrealistic to isolate and abstract the infant experience from the long-range development of the individual. Many studies span the infant period and ensuing phases of the life cycle. More critical is the fact that, ultimately, the only real value which the study of infant experience holds for us is its implications for human development and life's purposes as a whole. A central question, then, relevant to the focus in the present chapter is what are the parameters and consequences of stimulation in infancy as they bear upon the ideal type model we hold for the adult personality and the fit it has for the society we try to create?

Adult Models: Cognitive Dimensions. We shall not attempt to make a definitive statement of an ideal adult personality nor of the ideal society which best suits this ideal person, principally because we can conceive of a variety of ideal personality types as well as societal forms, each of which represents distinctive value orientations. It may be useful, however, to mention several concepts and principles which may contribute toward idealized forms of human functioning, some of which have been more or less implicit at various places in the chapter. These may be summarized in a few brief statements.

First of all, we assume that a primary developmental aim is cognitive complexity. This includes the acquisition of many and varied knowledge structures as well as a broad gauge of problem-solving styles and strategies, with which to acquire more information and use the information acquired most efficaciously. Orientations toward knowledge and problem-solving should be based both on multiple systems of high level abstraction (language, mathematics, music and art) as well as tune in to the concrete realities of the surround as the occasion demands. Problem-solving or cognitive styles ideally need to encompass the ability to handle predefined and repetitive tasks, yet have a rich and high development toward open-ended systems of problem-solving. The latter ability, as Getzels (1964) has recently defined it, is the ability to transcend phenomena in order to be able to generate new systems of problem-solving.

Adult Models: Socioemotional Sphere. In the emotional domain of personality-social functioning, idealized forms mean development of well-integrated personality styles in relating to others and working with phenomena in the physical world. They imply strong and well-defined but highly flexible modes of ego functioning, a definition of the self which defines, according to time and place, questions of self as against social identity and responsibility. They mean the acquisition of attachments to phenomena and persons which are many and varied. They mean competence and efficacy in R. White's (1959) terms. Development envisages a hierarchy of relative value strengths and attachment intensities, organized around a core set of values and emotional orientations to which an individual is dedicated in a unified life style and system. In sum, a balanced personality is constructed in terms of individuality of self definition in a context of social purpose. It requires an openness to new experience from the external world as well as intuitive depths built up in a meaningful past. These serve as the reservoir upon which the individual draws for his most intellectual and cognitive, as well as his most aesthetic and expressive modes of functioning.

Early Stimulation and the "Gifted" Personality. This order of characteristics is, unsurprisingly, most harmonious with those patterns of functioning and accomplishment which characterize the most intellectually and creatively developed members of almost any society. This is the import of studies on the intellectually exceptional (the "gifted") for understanding and appreciating idealized forms of development (Hollingworth, 1926, 1942; Miles, 1954; Terman et al, 1925, 1940 a and b, 1947; Witty, 1930, 1940). Perhaps the most outstanding and consistent finding in this class of highly intellectual being is the pervasive character of the stimulation from infancy typically appearing in their life history. The issue, in other words, is *not* merely one of heredity *versus* environment, it is rather that findings on the exceptionally bright underscore the indispensable role which stimulation, *both* early and longterm, play in the development of the human individual to his peak capacities.

The original historical survey by Cox (1926) provides extensive documentation on the existence of this experiential pattern in virtually all great figures of Western history. An analysis by this writer (Fowler, 1962a) of the early histories of 25 intellectually bright individuals, drawn from various sources, indicated that 72 per cent had experienced exceptionally intensive cognitive stimulation almost from birth. Of the other 28 per cent, no information was available on their early histories. There were, in other words, no cases reported where the evidence even hinted that development had proceeded under low or average conditions of stimulation. All 25 of these individuals had learned to read by the age of three to some degree of fluency, an achievement which is characteristic for the intellectually bright, almost invariably as a consequence of planned and/or facilitating efforts of the child's parents or other relatives.

Stimulation and Intellectual Development. If studies on the very bright disclose the unusual volume of stimulation employed for inducing the highest levels of intellectual complexity, it can also be inferred that the average individual in most societies is probably currently stimulated much less than his capacities warrant, even allowing for biological variation. Amount of stimulation, particularly early stimulation, appears to be one of the critical, distinguishing variables which determines the distribution in differences in IQ, academic achievement and other indices of intellectual competence. There is by now accumulated a vast array of investigations, both experimental and observational, which underscore the importance of experiential variables (Fowler, 1962a; Hunt, 1961). These range from experimental investigations on the impact, for example, of nursery school experience on IQ and of current infant and preschool programs on the culturally deprived, to exploration of the general conditions of marked social and sensory deprivation in animals (Harlow et al, 1960, 1962; Riesen, 1947, 1960; Scott, 1963) and in children (Deutsch, 1963, 1965; Gray and Klaus, 1965; Hess and Shipman, 1965; Riessman, 1962;

Weikart et al, 1964). The wages of severe deprivation are apparently grossly low intellectual levels and/or deviant, non-productive cognitive styles of development.

Individual studies of children's development longitudinally have shown even gross shifts in IQ, upward or downward, as a consequence of the quality of environmental experience (Bayley, 1949, 1955; Simpson, 1939; Skeels and Dye, 1939). Palmer, Haeberle and Kagan (1964) report IQ shifts greater than two standard errors of test measurement between ages six and 12 in 25 per cent of the subjects. Data was based on records from four longitudinal studies.

In studies of identical twins separated from infancy, IQ differences have varied as much as 24 points. Woodworth's (1941) analysis of data from a group of these studies yielded a correlation of .79 between twinmate differences in IQ scores and differences in the number of years of formal education. Perhaps the most dramatic findings appear in the gross, systematic differences in levels of intellectual and social competence reported by Skeels (1965) in adults who had experienced basic differences in the quality of maternal care and stimulation from infancy. Although problems of methodological control have always been great and uneven in investigations on this problem, there is currently comparatively little disagreement with respect to the key role which the quality and quantity of stimulation serves in the cognitive development of the child.

Neurophysiological Effects of Early Stimulation. On another level of investigation, recent experiments have revealed structural, physiological changes in early development which are a function of the amount and type of stimulation available. Krech, Rosenzweig and their associates (Bennett, et al, 1964;

Rosenzweig, 1966) have been engaged in a series of experiments, aimed at tracing changes in cerebral functioning as a consequence of variations in the amount and complexity of environmental stimulation. For obvious humanitarian reasons, the studies have been limited to experimentation with lower mammals, namely, rat populations. In these well-controled studies, two groups of newly weaned rats (about 25 days old) are provided with different experiences for a period of 80 days. In the enriched program, groups of rats are placed in large cages filled with a wide variety of rat "toys," such as, wheels, ladders, platforms, boxes and the like. In addition, they have frequent opportunities to explore open field situations and undergo varied forms of maze training. The enriched environments are, therefore, complex in both social and physical, environmental parameters. Control rats are housed in various conditions of impoverishment, but which have also included controls for isolation.

The findings of these studies have repeatedly demonstrated anatomical changes in the cortical structure of the sacrificed animals. Experimental rats have consistently shown significantly greater weight in brain cortex and in amounts of acetylcholinesterase and cholinesterase activity. These are enzymes which have been identified as important for synaptic transmission, that is, the transmission of messages among brain cells. Stimulated rats have also shown growth in the number of glial cells, cells which are believed responsible for nourishing neuronal cells, key cells for brain functioning.

Research on human beings will, of course, necessarily be limited to the accidents of experience, pending the discovery of techniques enabling study of neuroanatomical structures and/or neurophysiological processes without injury to the organism. In an early study ~~in the American Journal of Psychology~~

Donaldson (1892) reports that a post-mortem examination of the deaf-mute, Laura Bridgeman, revealed a distinct deficiency in the sensory areas in which Laura had lacked experience, compared with normal development in her other cortical spheres. These investigations furnish a perspective for establishing the neurophysiological, structural basis of experience and stimulation. It would appear that stimulation is actually reflected in structural growth of the cortex, which in turn enables the organism to function intellectually at more complex levels.

Cognitive Sets: Infancy as an Optimal Versus Critical Period. From the collected evidence, which unfortunately still includes too little in the way of systematic and experimentally controled, longitudinal studies, we are left with a number of vital but unresolved issues. How important or critical is the role of stimulation during the earliest infant phase of life, the period presently under consideration? Studies of the highly intelligent, as we have shown, suggest that there may be a special value in starting systematic stimulation with the neonate. The plasticity and responsiveness to stimulation of even the earliest sensori-motor cognitive operations in the form of visually directed reading and voluntary, head-turning responses have been experimentally demonstrated by B. White (1964, 1966) and Papoušek (1965), among others. From another angle, the observations on early infant deprivation of Goldfarb (1955) Provence (1962) and Spitz (1945) as well as the experimental studies of Riesen (1947, 1960) and others on chimpanzees and other animals, all converge on infancy as possible a critical learning period. Stimulation not received early enough at certain threshhold levels of form and quantity in any sensory modality may possibly lead to permanent, irreversible deficiencies in development.

For the infant, for whom the door to the world has just been opened, it is not a problem of learning the vast bodies of information which are piling up in every field of knowledge through the current technology of our era; although this may often be a learning experience quite appropriate for the later peiods of development in adult life. It is rather a problem of gaining detailed familiarity with the scope and configurations and the points of prominence in the proximal object and social world into which he is born. The constructions and abstractions he makes are necessarily simpler ones, as he discovers the basic definitions of space, form, movement, color and arrangement of conditions of the everyday world. Yet, as we have seen, surprisingly complex patterns can apparently be distinguished much earlier than long believed. More crucially--within the framework of some as yet uncertain distribution of biological ceiling potentials--rates of development of cognitive complexity may vary--even in the earliest infancy--in proportion to the rate at which (and the adequacy of organization in which) stimulation is presented.

Interpretation of the myriad of data remains blocked by methodological obstacles. As Orlansky (1949) concluded from an extensive review of the evidence, it is extremely awkward with humans to isolate and identify the long-range consequences of selective experiences in infancy. In all classes of studies, from accelerated stimulation to insufficient stimulation, there has been poor experimental control over stimulation experienced subsequent to infancy. Thus, although bright children have been early stimulated, stimulation has been typically a continuing encounter with inflated amounts of salutory stimulation throughout their developmental years. Formal experiments on infant stimulation have rarely followed the course of the child's development beyond the infant period. On the other hand, deprived infants have modally confronted continuing, marked deficiencies in the quality and quantity of stimulation experienced.

Despite methodological limitations, it would appear reasonable to hypothesize infancy as an optimal period for launching certain forms of stimulation. The shape of stimulation may be less important for the information imparted than for its importance in laying down types of platforms--cognitive learning sets-- upon which to build all later forms of developmental learning. These may be defined as orientations toward learning or of "learning to learn." They involve learning how to learn and a set of attitudes, expectations and readiness to acquire new information and concepts. Cognitive learning sets may be very general, orientating the individual toward the acquisition of general knowledge, or highly focused, inclining the individual toward learning in specific subject areas or language systems. There are no experiments explicitly aimed at studying the development of cognitive learning sets in infants. Investigation of learning sets in children (Reese, 1963) has been limited to the study of extremely simple, discrimination learning task sets, using only short-term learning paradigms.

Overall, the evidence suggests advantages for intensive, early stimulation which may accrue over the long pull. By the same token, there are marked and sustained disadvantages for under-stimulation in the infant foundation period. In some way early success or failure compounds itself, leading to continuing high or low levels of intellectual functioning throughout the course of development unless radical intervention takes place. Early stimulation may not only provide earlier, a greater fund of knowledge, but may lead to the establishment of cognitive learning sets. These sets help the child to learn subsequent developmental tasks with greater ease and advantage--to some degree as they are related to the specific language systems and domains of knowledge in which acquired.

Conversely, the under-stimulated infant must confront ensuing problems of development from a depressed platform of cognitive learning sets. Lacking these foundation sets, over a series of stages of development, the child finds himself cumulatively handicapped in the amount of knowledge and ability to cope, to acquire knowledge and to learn. Each successive, cognitive developmental task level finds him less prepared, less equipped with the learning sets cumulatively required, to learn the component dimensions of each new stage, to progress to successively higher levels and modes of cognitive operations. As the findings of Deutsch on disadvantaged urban, Negro slum children have revealed, the gap between their levels and the developmental norms of intellectual development and school achievement widens progressively from the first to the middle grades (Deutsch, 1963; Deutsch and Brown, 1964). There is also probably a social identity and developmental role process at work which reinforces positive or negatively the child's self image as a successful or non-successful learner. Only massive doses of highly skilled, remedial stimulation can apparently reverse this decelerating developmental learning process and alter the social role which congeals around such a psychosocial condition of cumulative cognitive deprivation.

The concept of deprivation is best defined in a relative sense. Each infant and child that does not receive optimal stimulation up to the levels of which his system is biologically capable is being deprived to that degree of the opportunity for maximum development and use of his cognitive abilities.

At any given point in development, deprivation is a measure of the discrepancy between innate potentials and ability levels attained. It is an inverse function of the proportions of adaptive stimulation cumulatively encountered--perhaps well into adulthood.

We may recall that McGraw's (1935) experimental twin, Johnny, was found to have maintained his cognitive and attitudinal advantage in problem-solving in the gross-motor sphere over his control twin four years later at the age of six. This was in spite of the fact that the four intervening years had apparently been lived by both boys in a similar and relatively adequate environment. For the most part, he maintained his general, cognitive-emotional advantage and his advantage in well-stabilized, complex skills, losing his relative position largely where physical alterations in bodily proportion through growth created an essentially new cognitive-motor task to be learned. Yet it was also clear that the learning sets established were anchored to particular cognitive domains and functions--gross-motor learning as opposed to motor manipulation in a fine-grained form or in verbal systems.

Particularly vivid light on the longterm consequences of early stimulation is provided by the classic study of Burtt (1932, 1937, 1941), although the stimulation period embraced only the later phases of infant development, namely, from age 15 months to three years of age. Over this 15-month period, Burtt read one 20-line passage of Greek each day to his infant son, introducing three new passages every three months. Since the program was completely halted at the age of three years, we have an exceptionally sharp test of the impact of early stimulation upon later intellectual functioning, and in an unusually well-defined, if limited, form. Differences in the ease of learning new passages of Greek, as compared with learning passages earlier read to the boy, were significantly in favor of the previously exposed material at the ages of eight-and-a-half and 14. It was not until the age of 18 that differences became no longer detectable.

In a longitudinal study of the later achievements of early readers, a process, incidentally, more cognitively complex than rote retention learning, Durkin (1964, 1966) found that early readers continued to realize a significant advantage in all aspects of reading achievement, through the sixth grade level over grade norms, holding intellectual ability constant. This is a more systematic and controled investigation than most surveys of the intellectually bright, even though, unlike Burtt, we are again studying the impact of early stimulation without control of intervening experiences.

All in all, it would seem that variations in the intensity and type of early stimulation produce pervasive, longterm differences in development. Certain kinds of cognitive sets, which may embrace *both* conceptual orientations toward learning (or "learning to learn") *and* enhanced familiarity with particular content can get established which are distinct assets for later opportunities to learn and develop. But these early sets are only permanent if gained, and lost if not early developed, *in proportion to* (1) the quality, area and quantity of the early experience and (2) contingent upon the persistence, quality and type of the later facilitating and/or remedial stimulation experienced.

Cognitive Styles: The Forms of Functioning. One aspect of cognitive functioning which has hardly been touched in infancy or early childhood, is the question of cognitive style. Historically, consideration has been given largely to *levels* of intellectual development with attention to styles limited to broad definitions of area or function (e.g., verbal, social, gross- and fine sensori-motor, etc.). There has been some special interest in sensori-motor forms of problem-solving (e.g., Richardson, 1932, 1934; McGraw, 1935). This past dearth of interest is to be expected from the essentially empirical-descriptive and/or conditioning approaches which our survey has indicated have historically preempted the field of infant mental processes. Logically, intellectual processes must be seen first within a framework of cognitive processes, providing for the possibility of alternative, means-end systems of problem-solving, before any particular forms or styles of cognitive functioning can even be identified, let alone studied.

Studies of adult personality-cognitive functioning (Gardner et al, 1959, 1960; Witkin et al, 1962) and, recently, studies of children's later development (Hess and Shipman, 1965; Kagan, Moss and Sigel, 1963; Santostefano, 1964; Santostefano and Paley, 1964) are establishing the existence of a number of different strategies for processing information and problem-solving. Such styles as analytic, relational, categorical-inferential, field-articulated and field-dependent, scanning, and the like are found to have currency as relatively stable styles of individual functioning. Santostefano (1964) and Kohlberg (1962) have found evidence that there may be developmental trends in cognitive styles; these vary from more diffuse, associational types of style in the early years to general, abstract and classificatory styles and analytic and logical orientations toward problem-solving at later phases of development. This general scheme of sequences of cognitve development, which defines infant mental processes as simple, differentiated and tied to the immediate and concrete, sensori-motor scene, parallels Piaget's (1952) and Werner's (1957) theories of development.

The information upon which these theories are based, as well as developmental studies such as those of Kohlberg and Santostefano, however, focus on the developmental structure of cognitive processes. Since both the theories and the studies take poor account of prior experience in terms of the conditions and mechanisms of development, it is difficult to ascertain whether these sequences are indeed the natural order of things developmental. Moreover, validating studies are not only merely cross-sectional but also disclose only general trends, not uniform patterns at any stage. What is needed are longitudinal investigations, which explore systematically the forms of problem-solving under diverse conditions and at different levels of abstraction. It is at least conceivable that under this kind of search, cognitive functioning would emerge as a variable organization of cognitive styles and patterning of abilities, according to the forms of stimulus organization and sequences to which the individual is cumulatively exposed in development. Measuring development solely at the higher, most general, Piaget-type levels of cognitive organization and abstraction may indeed reveal uniformities. Such an approach may also blur individual differences operative at intermediate and lower levels of organization.

The contrast between McGraw's (1935) longitudinal stimulation program in the vein of gross, sensori-motor operations as compared with the distinctly symbolic mediational programs of Fowler, Terman and others, for example, indicates that development can be guided into different channels[1] almost from the beginning. Thus, motor-trained Johnny was motorially but not verbally competent and vice versa. The effectiveness of early verbal stimulation programs also strongly suggests that, while sensori-motor operations may predominate through the first year of life or so, engagement in language transactions can be facilitated during this first year. To the extent that systematic language stimulation is provided, verbal mediational, self-regulation of activity may assume a proportionately greater role compared to the non-verbal, problem-solving instrumentation of behavior predominant in McGraw's twin, Johnny. In view of the overwhelming leverage which only language systems can provide for acquiring the complex conceptual systems involved in our progressively more intricate technology, early mastery of verbal forms may well be a primary developmental advantage.

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[1] Some overlapping between orientations toward and area--set--and the forms of functioning--style--is evident. In a sense, each area defines the cognitive styles of functioning required, broadly speaking.

Presumably one of the central principles which should be underscored with respect to orientations toward early stimulation is the assurance that the door will not be closed to any particular form, sphere or modality during the earliest period. If the early period, as the evidence suggests, is heavily determining if not crucial for later development, then attention should be directed at insuring that a wide range of stimulation across perceptual, formal and content spheres of reality is liberally bestowed upon every child in the early phases. Stimulation should cover all sensory modalities and encompass both the social sphere and the thing world and both non-verbal and verbal mediational forms. In the absence of a broad, well-constructed foundation the developmental superstructures may well totter or be dwarfed--as is too often true of the development of the socially disadvantaged populations of children.

Yet, there is still room for speculation as to whether it may be wise in some instances to select out by design a particular area--such as art, music or mathematics--within which to engage the full cognitive and imaginative participation of the child from the earliest moments of life. On the one hand, there is the general record of the highly intellectual with their broad range of superior competencies in cognitive and personality functioning. On the other hand, there is the evidence of the great musicians for example. Attainment of really high competence in certain spheres may be contingent upon ~~the~~ initiating stimulation programs very early and pursuing them with dedicated intensity over the developmental span. As long as early focus is not at the cost of an elaborated foundation and the development of variegated cognitive strategies (and aside from questions of biological contribution) this issue may contain the seed of special forms of greatness.

Methods of Stimulation: Open Versus Closed Systems--Structure and Creativity. From another vantage point, the issue is not merely one of stimulation versus non-stimulation nor of the levels and forms of stimulation which should be provided in infancy. Rather the methods and conditions under which stimulation is projected are intricately involved in defining the problem of stimulation in (early) cognitive development. A central issue is the amount of structure to be provided.

The main concern here is not merely what but how the infant is to acquire information most efficiently if not by means of some systematic presentation. From the point of view of arousing motivations, the act of discovery is vital to learning as, today, many are aware but few can implement. But curiosity-discovery-inquiry orientations are very different processes in the trained, scientific mind of the adult from those of the infant and young child.

As Bruner (1961) has pointed out, significant discoveries are likely to be made by the well-prepared mind. We want to develop exploratory types of children with high levels and many varieties of curiosity in their motivational systems. We want them to be open-ended and creative, to be able to originate freely constructions of their own, new combinations of things, new discoveries.

The accumulating evidence on infant and child learning suggests that the manner of arranging the information may be the critical factor for maximizing cognitive learning, while sustaining open-endedness and curiosity, exploratory orientations in children (Collard, 1962; Fiske and Maddi, 1961; Lucco, 1965). It is apparently possible for the adult to guide the child systematically in stimulation programs, presenting new information, providing that the teacher takes account of certain conditions in the manner and form of presentation. From the investigations of curiosity motivation in infants and children, it is evident that we need to present material generally in some continuously novel manner. The same types of concepts can be presented, for example, by presenting an extensive variety of examples to illuminate the concepts. The work of Dember (1965), Earl (1961) and Thomas (1965) show that presenting stimuli always a step above the complexity of the present organization of the child's concepts tunes optimally into the preferred mode of cognitive functioning of the infant and child. Both of these principles have been incorporated in techniques which have been found most promising for exciting and sustaining the motivation of infants and young children by this (Fowler, 1962b, 1964, 1965a and b) and other investigators (Fowler, 1962a; McGraw, 1935).

In brief, the child attends to--and therefore learns--most readily those patterns of stimuli which are partially but not completely discrepant in content (novelty or interest value) and form (complexity value) from stimulus patterns which have already been assimilated to form his mental structures. Learning, in other words, proceeds most rapidly and smoothly when stimulus sequences are programed, step-by-step, so as always to contain balanced combinations of familiar elements, relations and attachment values in union with new and slightly more complex components.

But while, novelty and judicious grading of material and sequencing operations may maximize curiosity motivations and learning, there are few studies (none on infants) which have tackled the differential effects of open versus closed systems of presentation upon creativity. Those interested in the young child, until very recent history, have been preoccupied with socio-emotional relations, and research has been confined to cross-age, time-slice comparisons. Development has been viewed as the unfolding of structures and methods in themselves were seldom treated as a serious problem for study and variation. The rise of the nursery school and child guidance movements, around the turn of the century, was originally a healthy reaction against the authoritarian constraints and pedantic, rote learning definitions of ancient tradition. As often the case, however, the "movement" prescribed a single framework of idealized methods. The openness of a sieve (extreme permissiveness), diffusion of boundaries and a cavalier unconcern for problems of organization, sequencing or even subject matter itself have been the order of the day. Specification of content, form, method and attitude have all been fuzzy, leaving much confounded.

It is clear, from studies we have reviewed here and elsewhere (Fowler, 1962a, 1966), that guided stimulation provided on some systematic basis is productive for cognitive learning in infants and children. Studies at the nursery school level (ages three to five), which have directly compared guided stimulation with more or less standard, unstructured nursery school programs have reported generally favorable and sometimes significant IQ test and other cognitive gains for experimental children over their controls (Carr, 1938; Fowler, 1962, 1965b; McCandless, 1940; Peters and McElwee, 1944). A number of studies have produced definite advantages in specific content areas and cognitive skills,such as in reading (Fowler, 1965b) and musical ability (Jersild and Bienstock, 1931, 1934).

It is equally evident that systematic stimulation, started early, is associated with many signs of favorable outcome in the areas of personality and social development in later childhood and adult life. (Fowler, 1962a; Hollingworth, 1926, 1942; Miles, 1954; Terman et al, 1925, 1940a and b, 1947; Witty, 1930, 1940). Early stimulated children are found, both at the time of stimulation and throughout the course of development, to function generally more successfully and to derive more satisfactions from their activities and relationships than less stimulated children. In only a small minority-- around 20 per cent or less-- do significant emotional problems appear and, where evident, are apparently a by-product of social role problems traditionally associated with invidious American attitudes toward the intellectual.

There have been only two experimental studies on this problem located (Fowler, 1962a). Persistent, intensive stimulation of a 12- to 20-month-old infant by Welch (1940), which reduced the child's motivations significantly, was evidently a consequent of the repetitive, unimaginative methods employed. In the second study, the precipitous motivational decline of interest in reading in the author's two-year-old (Fowler, 1962b)--following an accelerating interest over many months--was directly associated with enrollment in and social adjustment to an especially aggressive and older nursery school peer group.

A significant feature of these studies inheres in the contrast between methods employed. Although the motivational decline was marked in both experiments, the source of emotional disruption varied. The source was intrinsic to the conditions of stimulation (methods) in Welch's study but extrinsic to the learning situation (social adjustment at nursery school) in the author's experiment. One consequence of this difference is suggested by the later strong recovery of Velia's motivations for reading at a later period--using the same play-oriented methods employed in the earlier period--just at the point she began to adapt socially to nursery school. ¶The extent to which play-oriented, activity methods have been employed in infant and child early stimulation programs is considerable and, where used, appear to serve a variety of important functions. Not only do play methods appear to facilitate learning and enhance the child's enjoyment of the learning process at the time, but there are longterm, developmental consequences. There is evidence from the biographies of figures like John Stuart Mill (1960) and Norbert Wiener (1953), who were generally early stimulated by traditional didactic methods with small attention to the dimensions of play, that they derived somewhat less early and longterm satisfaction from learning than others who were early stimulated under conditions where play assumed a more prominent position(Cox, 1926; Davidson, 1931; Fowler, 1962a and b; Root, 1921; Stoner, 1914; Terman, 1917; Witte, 1914). The lack of exact and comparable bases for measurement make such interpretations tenuous, however, particularly because of the value laden aspects of the concept of satisfaction. The high level of intellectual productivity, creativity and ~~intellectually~~ social acclaim of high achievers in their subsequent adult lives further confounds the problem.

Play features in many theories of development (Bühler, 1930; Isaacs, 1945; Piaget, 1962) in which it is believed to serve a basic role in developmental learning process, particularly during early childhood. There are several focal dimensions which have been identified as useful, among these are the social role rehearsal functions, the working through of emotionally charged situations and relationships, and the acquisition of mastery over reality dimensions (physical and social), through experimental manipulation in non-committed or fantasy circumstances. All three definitions seem to provide much relevance for cognitive developmental learning.

When learning tasks are immersed in play settings the child can confront the tasks while involving a variety of socioemotional and cognitive functions and, essentially, in a situation which is not defined as "for keeps." Indeed he can take a major part in constructing his own definitions of reality in the process, an aspect of play that seems especially designed to develop creative styles of cognitive functioning. To this extent, freeplay orientation in infant crêches and nursery schools--however limited in the range, selectivity, organization and sequencing of concepts--do permit the child to make his own syntheses, both in the sociodramatic play sphere and in construction play with a variety of plastic or semi-open-ended toys and materials (blocks, clay, collage, tinker toys, etc.). Interesting in this regard are Smilansky's (undated) observations on deprived Asiatic (Sephardic) Jews in Israel. The children were found to be both cognitively retarded in most measures of functioning at kindergarten age and to engage in only low level forms of sociodramatic play.

While the bulk of the evidence is definitely weighted in the positve direction with regard to the influence of early stimulation upon personality and social processes in human development, tightly designed experiments on this problem have yet to be developed. Even more rare are studies which address themselves to the problem of covering identical or similar stimulus programs under two distinct sets of conditions or methods, especially as method bears upon originality and creativity. One of the few tests of this kind is reported from the USSR. Luria (Levit, 1935) compared pair members of five pairs of (apparently) four-year-old, identical twins on their ability in block construction tasks, following four months' training in two methods of figure reproduction. The task required each child to build a block structure resembling an experimental model. Under one training method, the method of elements, the child could see the exposed block units of which a model was constructed. Under the second method, the method of models, the model was covered with paper, leaving only the general configuration of the block model exposed. ¶ While, initially, the method of elements produced a higher performance level, twins trained in the method of models, gradually overtook the skills of the other twins. Substantial differences remained between the trained pairs ten months later. The older age of these children limits the conclusions which may be drawn from this sparsely reported study. On these relatively limited tasks, these four-year-olds were evidently quite familiar with the elements involved, and some elementary principles of combining, shifting the problem to one of learning how to combine numerous elements to produce specific final forms. The problem was one, therefore, of developing synthesizing, semi-open-ended orientations, using conceptual components with which the child was already quite familiar.

The relationship between these two contrasting methods of training and the issue of the acquisition of information structures ~~and~~ versus the development of creative orientations is at the core of all questions on developmental stimulation. The crucial problem is how to generate creative cognitive styles, maximizing the individual's ability to produce creatively, *while* building in detailed information systems of sufficient substance to develop *significantly* creative individuals. Studies of early and longitudinal developmental stimulation suggest that both substance and style must be accomodated--at every age--from infancy on. Structure and sequencing of stimulation is a framework of conditions within which flexibility, play-orientations, active mastery and analytic but open-ended construction are generated by the manner of presentaticn and the nature of the tasks demanded.

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